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IE MINERALOGICAL MAGAZINE
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The crystal-structure of the bismuth oxyhalides.

By F. A. Bannister, M.A.
With chemical syntheses by M. H. Hey, M.A., B.Sc.
Assistant-Keepers in the Mineral Department,
British Museum of Natural History.

[Read November 1, 1934.]

DE SCHULTEN[1] published a crystallographic and optical investigation of the bismuth oxyhalides in 1900. He succeeded eparing minute square plates capped with pyramidal planes, but ntly the difficulties of manipulation prevented the measurement terfacial angles. He did, however, record a negative uniaxial observed in a direction perpendicular to the plane of the square s of all three salts BiOCl, BiOBr, and BiOI. The present work ndertaken to extend A. de Schulten's observations, to measure xial ratios, and to determine the crystal-structure.

was desirable to obtain single crystals sufficiently large to mount oniometric and X-ray work. This was finally achieved by a ion method. A concentrated solution of bismuth chloride in ochloric acid was poured into a small crystallizing dish, and then, bing as little as possible the contents of the dish, layers of ochloric acid of diminishing concentration were slowly added. lish was then filled to the top with water and a surrounding dish also completely filled with water. The larger dish was covered with a glass plate and left undisturbed at a constant erature of about 18° C. for three days. Prolonging the duration experiment did not produce larger crystals, but sometimes a

[1] A. de Schulten, Bull. Soc. Chim. Paris, 1900, vol. 23, p. 156.

re-solution or the deposition of polycrystalline spherules on the faces of the single crystals already formed. It was found advisable to drain off the liquid at the end of three days and allow the inner dish to dry. The best crystals were always found on the inside wall of the smaller dish, and a few of these, after several unsuccessful attempts, were withdrawn on very thin glass fibres without any adhesive. The greatest care is necessary during this operation to avoid crushing or bending the very soft minute plates. Owing to their extremely perfect basal cleavage preservation of the single crystals in a medium under a cover glass is almost impossible. The above procedure was successful in producing square plates of both BiOCl and BiOBr measuring $0{\cdot}3 \times 0{\cdot}3 \times 0{\cdot}05$ mm. The preparation of single crystals of BiOI is more difficult. The formation of the insoluble bismuth iodide BI_3, which is not readily hydrolysed, is prevented by dissolving bismuth oxide Bi_2O_3 in an excess of hydriodic acid. The compound $HBiI_4$ is then formed, which is hydrolysed by adding a large excess of water and gradually raising the temperature to boiling-point. Very thin red folia of BiOI obtained by this method when examined by X-ray photographs are found to consist of a small number of single crystals superposed almost in parallel position.

Crystallography.—The basal reflections from a number of BiOCl plates were examined with a pin-point light source. The basal planes not in contact with the glass dish during growth show a light-figure consisting of four V-shaped reflections which, prolonged by straight lines, form a rhombus, not quite a true square. These reflections come from four very flat pyramid faces inclined to the basal plane by 1° 18¼′ and 1° 29¼′ respectively. The indices of these planes referred to the axial ratio $a : c = 1 : 1{\cdot}895$ are approximately (1.1.118) and (1.1.103). Similar measurements of a number of BiOBr crystals show flat pyramidal faces inclined at 4° 23½′ and 4° 51′ to the basal plane. These angles correspond to planes (1.1.38) and (1.1.34) respectively, referred to the axial ratio $a : c = 1 : 2{\cdot}068$. Truly square light-figures were also observed on one crystal reflected from the plane (1.1.84) inclined at 2° 3′ to the basal plane. No crystals of BiOCl or BiOBr prepared by this method showed the planes (111) and the prism faces (110) were always too small to yield reflections. The BiOI preparation yielded crystals showing only (001) sometimes with edges parallel to (110). Single crystals of both BiOCl and BiOBr yield Laue photographs showing true tetragonal symmetry and the apparently orthorhombic form of the pyramid faces vicina

(001) is possibly due to the distorting influence of growth in contact with the cylindrical surface of the crystallizing dish.

X-ray measurements.—Rotation photographs of all three salts were obtained about the [110] and [001] axes, the former axis being parallel to an edge of the square plate and the latter, of course, perpendicular to the plane of the plate. The sub-parallel growths of BiOI did not yield photographs so perfect as those of BiOCl and BiOBr, but accurate cell-dimensions were obtained and the relative intensities of the basal diffractions were readily estimated. Slightly oblique-set rotation photographs of BiOCl and BiOBr were also used for comparison of the intensities of the basal diffractions. Oscillation photographs show that the space-group is $P4/nmm = D_{4h}^7$ and the unit cells contain 2 BiOCl, 2 BiOBr, and 2 BiOI respectively.

Table 1 gives the unit-cell dimensions, specific gravities, and the crystal-structure parameters for the bismuth oxyhalides. Data for the isostructural matlockite [1] and PbFBr [2] are added for comparison.

TABLE 1. *X-ray data and specific gravities of the bismuth oxyhalides, &c.*

	Unit-cell dimensions		Calculated axial ratio.	Specific gravity		Crystal-structure parameters	
	a.	*c*.		Observed.	Calculated.	*u*.	*v*.
BiOCl ...	3·89	7·37 Å.	1 : 1·895	7·717	7·70	0·171	0·650
BiOBr ...	3·92	8·11	1 : 2·068	8·082	8·07	0·153	0·650
BiOI ...	4·01	9·14	1 : 2·279	7·922	7·90	0·132	0·667
PbFCl ...	4·09	7·21	1 : 1·763	7·05	7·16	0·208	0·650
PbFBr ...	4·18	7·59	1 : 1·816	7·52	7·61	0·195	0·650

Data for PbFCl from the mineral matlockite, F. A. Bannister, 1934.
Sp. gr. of BiOCl, BiOBr, and BiOI, A. de Schulten, 1900.
Sp. gr. of PbFBr, W. Nieuwenkamp and J. M. Bijvoet, 1932.

All possess the matlockite type of crystal-structure. The parameters of the bismuth and halogen atoms in the oxyhalide structures have been evaluated from a comparison of intensities of the basal diffractions (table 2). Intensities of diffraction for all other types of lattice-plane also agree well with the calculated structure-factors. The formal development of the crystal-structure from the space-group and intensity data has previously been given for matlockite.[2] It is unnecessary to repeat the treatment in detail for the bismuth oxyhalides. Their crystal-structures are defined as for matlockite by the atomic positions: Bi, $00u$, $\frac{1}{2}\frac{1}{2}\bar{u}$; X, $00v$, $\frac{1}{2}\frac{1}{2}\bar{v}$; O, $\frac{1}{2}00$, $0\frac{1}{2}0$,

[1] W. Nieuwenkamp and J. M. Bijvoet, Zeits. Krist., 1932, vol. 82, p. 157. [C.A. 5-177.]

[2] F. A. Bannister, Min. Mag., 1934, vol. 23, pp. 587–597.

where Bi takes the place of lead, oxygen of fluorine, and X represents chlorine, bromine, and iodine in turn.

TABLE 2. *Comparison of observed intensities (I) and calculated structure-factors (S′) for rotation photographs of single crystals of PbFCl, BiOCl, BiOBr, and BiOI.*

Diffracting	PbFCl		BiOCl		BiOBr		BiOI	
plane.	*I.*	*S′.*	*I.*	*S′.*	*I.*	*S′.*	*I.*	*S′.*
(001)	m	24·2	s	37·4	s	35·2	s	38·5
(002)	vs	−59·6	s	−37·8	m	−27·9	m	−23·9
(003)	mw	−29·3	vs	−52·0	m	36·0	nil	−6·8
(004)	w	27·4	ms*	−29·7	vs	−65·5	vs	−81·6
(005)	s	58·0	ms	38·1	nil	9·8	ms	−47·9
(006)	vvw	10·0	vs	60·2	vs	66·8	ms	52·3
(007)	m	−49·5	vw	11·0	mw	28·5		
(008)	vw	−17·5	mw	−26·2	vvw	12·1		
(009)	ms	29·0	s	−35·5	w	−21·1		
(0.0.10)	not on film		vvw	−8·9	s	−32·4		

* (004) coincides with (113) on the rotation photograph of BiOCl; both are equally strong on oscillation photographs from which the tabulated intensity of (004) has been estimated.

Cu−Kα radiation with nickel filter was used, $\lambda = 1{\cdot}539$ Å.

s = strong, m = medium, w = weak, vw = very weak, &c.

The S' values are calculated from the following expressions:

For $h+k$ even and both h and k even: $S' = \mathrm{Pb}\cos 2\pi ul + \mathrm{Cl}\cos 2\pi vl + \mathrm{F}$.

For $h+k$ even and both h and k odd: $S' = \mathrm{Pb}\cos 2\pi ul + \mathrm{Cl}\cos 2\pi vl - \mathrm{F}$.

For $h+k$ odd: $S' = \mathrm{Pb}\sin 2\pi ul + \mathrm{Cl}\sin 2\pi vl$.

The accuracy of cell-dimensions measured by the rotation photograph method was checked by powder photographs. A small amount of each salt was finely ground and painted on a thin glass fibre, then centred and left stationary in the X-ray beam. Exact agreement in cell-dimensions was obtained by the two methods, but the powder photographs show a general increase in intensity of all the (00l) lines and a marked blackening of these lines near the equator. Both facts are due to the minute cleavage flakes of oxyhalide adhering with their cleavage faces parallel to the axis of the glass fibre. A precipitate of BiOCl was then prepared by adding a large amount of water to a solution of bismuth chloride. The fine-grained material that remained floating on the water-surface was filtered and dried and a small compact portion mounted at the end of a glass fibre. In this way it was hoped to prevent the orientation produced by the grinding and painting process mentioned above. The intensities of the (00l) diffractions on the resulting powder photograph are considerably reduced and only the first three orders are faintly visible. The high

ller diffractions (*hkl*) are somewhat diffuse and show that the erage grain-size of this specimen of BiOCl is approximately 10^{-6} cm. is natural to assume that the grains are minute plates and these obably possess an average thickness less than 10^{-6} cm. Thus the *0l*) lines should be broader, and therefore weaker, than the (*hkl*) es.

The evaluation of interionic distances for the three oxyhalides of smuth, matlockite, and lead fluobromide leads to some interesting nclusions (table 3). The distance between the centres of bismuth

TABLE 3. *Interionic distances calculated from the crystal-structures of the bismuth oxyhalides, matlockite, and lead fluobromide.*

	Bi–O.	Bi–X.	X_v–X_v.	X_v–$X_{\bar{v}}$.	Theoretical diameter of X.
OCl... ...	2·32	3·05	3·89	3·53	3·60 Å.
OBr... ...	2·32	3·20	3·92	3·69	3·92
OI	2·34	3·38	4·01	4·17	4·40
	Pb–F.	Pb–X.	X_v–X_v.	X_v–$X_{\bar{v}}$.	Theoretical diameter of X.
FCl* ...	2·54	3·07	4·09	3·62	3·60 Å.
FBr ...	2·56	3·18	4·18	3·73	3·92

* Data for matlockite and the artificial salt.

X represents Cl, Br, or I.

X_v–X_v is the shortest interionic distance in one and the same layer of halogen s placed at $00v$.

X_v–$X_{\bar{v}}$ is the shortest interionic distance between contiguous layers of halogen s placed at $00v$ and $\frac{1}{2}\frac{1}{2}\bar{v}$.

d oxygen ions can be calculated directly from the values of u given table 1, and is almost identical for all three oxyhalides. Assuming at the diameter of the oxygen ion O^{-2} is 1·32 Å., the diameter of e bismuth ion Bi^{+3} cannot therefore be greater than 1·01 Å. The rresponding distance between the lead and fluorine ions of matlock- and lead fluobromide yields a maximum diameter of 1·22 Å. for e lead ion Pb^{+2}.

The halogen ions form a double layer $00v$, $\frac{1}{2}\frac{1}{2}\bar{v}$ in all five structures. th for bismuth oxychloride and matlockite the distance between o chlorine ions in one and the same layer and also between con- uous layers is not less than the usually accepted value for the meter of the univalent chlorine ion, 3·60 Å. The observed inter- logen distance between contiguous layers for the two bromine salts however, a good deal less than the diameter of a univalent bromine , 3·92 Å. In both these salts, therefore, we obtain evidence that small positively-charged bismuth or lead atoms are polarizing, i.e. torting, the large negatively-charged bromine atoms; moreover,

the polarization is more marked along the *c*-axis, i.e. between contiguous layers; than along the *a*-axis. Bismuth oxyiodide is an example of a salt in which the distortion produced by the bismuth kation compresses the double iodine layer in both directions, so that the distance I–I in one and the same layer (4·01 Å.) and between contiguous layers (4·17 Å.) is considerably less than the diameter of an undistorted univalent iodine ion (4·40 Å.). The red colour of the oxyiodide is also an indication of marked polarization.

Crystal-structures of the layer type not infrequently exhibit asymmetric polarization of the anions. The interest of the bismuth oxyhalide structures lies in the progressive polarization observed in passing from the oxychloride to the oxyiodide. The more pronounced the polarization the more pronounced become the 'layer-type properties'. Single crystals of BiOBr possess a more perfect *c*-cleavage than crystals of BiOCl, whilst several attempts to grow crystals of BiOI resulted in folia several millimetres in area but $< 0{\cdot}01$ mm. thick.

A large increase in birefringence would also be expected for the oxybromide and oxyiodide. A uniaxial interference-figure with negative sign was observed for all three oxyhalides. Unfortunately, refractive index and birefringence measurements are extremely difficult and, so far as my own trials are concerned, impossible excepting for the oxychloride. The observation of the Becke line when the tiny flakes are pressed into a sulphur-selenium melt becomes uncertain owing to the thinning-out by cleavage. Presumably the shearing produces thinner flakes of the oxybromide and iodide than of the oxychloride. The same difficulty was also encountered in endeavouring to measure the refractive indices of artificial PbFCl precipitated in the form of a powder. It was, however, comparatively simple to observe the Becke line with crushed flakes of the mineral matlockite. The refractive index data obtained are ω 2·15 for BiOCl, and 2·11 for matlockite (cf. value obtained by the prism method, 2·124), λ approximately 6708 Å.

The difficulty of obtaining reliable optical data on fine-grained material of high-refractive index and birefringence is also encountered when proceeding to distinguish between two very rare minerals, bismoclite and daubreeite, both oxychlorides of bismuth. In the circumstances their distinction rests entirely on chemical and X-ray work, and therefore forms a mineralogical application of the above study.

Professor E. D. Mountain recently submitted for X-ray examination
ie unique specimen of his new mineral bismoclite (this vol., p. 59),
hich has a chemical composition close to that of bismuth oxy-
loride. A powder photograph of a small fragment detached from the
mpact, creamy-white nodule is exactly identical in line positions
id intensities with a powder photograph of the artificially prepared
lt, and the freedom of the powder lines from flecks shows that the
erage grain size is $< 10^{-4}$ cm. Both the X-ray and chemical data
ove conclusively that the mineral is native bismuth oxychloride.
rofessor Mountain suggested that the mineral might be closely
lated to daubreeite, a hydrated oxychloride of bismuth described
id analysed by Domeyko in 1876.[1]

Bismuth minerals other than bismuthinite, owing to their powdery
aracter, are so liable to be confused with one another that it was
ssential to secure for comparison one of the specimens of daubreeite
riginally described by Domeyko himself. Professor A. Lacroix
ndly loaned to us several specimens labelled daubreeite, Cerro de
azna, Bolivia, from the mineral collection of the Muséum National
Histoire Naturelle, Paris. Of these only one contains chlorine.
he remainder are earthy specimens of kaolinite impregnated with
smuth arsenate. These are probably to be identified with the
ncertain mineral taznite, described by Domeyko[2] in 1877 as an
senio-antimonate of bismuth from the same locality. There is no
ubt that these specimens, most of which came from Daubrée's
rivate collection, were sent by Domeyko from Bolivia, but owing to
ie similarity in appearance of earthy bismuth minerals they were
belled incorrectly.

It is interesting that the one specimen which contains chlorine and
smuth, but no arsenic, was given to Professor Lacroix by Daubrée
mself in 1894. This specimen, labelled daubreeite, Cerro de Tazna,
olivia, catalogue no. 94.247, is a pale-yellow compact mineral
owing remnants of columnar structure suggesting alteration from
smuthinite. It is admixed with a clay mineral, probably kaolinite,
id on account of the small amount of material available and its

[1] I. Domeyko, Compt. Rend. Acad. Sci. Paris, 1876, vol. 82, p. 922; Minera-
ía, 3rd edit., Santiago de Chile, 1879, p. 297. Not to be confused with
ubreelite, $FeCr_2S_4$, a mineral associated with troilite in meteoric irons, and
o named after G. A. Daubrée in the same year by J. L. Smith.

[2] I. Domeyko, Compt. Rend. Acad. Sci. Paris, 1877, vol. 85, p. 955, Min., 3rd
it., 1879, p. 298. Preliminary qualitative chemical tests and X-ray work suggest
at the so-called taznite is impure compact atelestite, basic bismuth arsenate.

obviously impure nature a chemical analysis was not attempted. Powder photographs of picked fragments, free from clay, are almost identical with powder photographs of artificial bismuth oxychloride, and at first the small differences of pattern were thought to be due to orientation (cf. p. 52). Measurement, however, showed that the unit-cell dimensions differ slightly, and further photographs of other samples confirmed this result.

	a.	*c*.
Artificial BiOCl	3·89 ± 0·01	7·37 ± 0·02 Å.
Bismoclite, BiOCl	3·89 ± 0·01	7·37 ± 0·02
Daubreeite, BiO(OH,Cl)	3·85 ± 0·01	7·40 ± 0·02

The difference in cell-dimensions of daubreeite and BiOCl is quite sufficient to cause an alteration of pattern which the eye can readily detect. Certain lines which are resolved as doublets in the BiOCl photograph either close up or widen out in the daubreeite photograph. The pairs of lines which show this effect to a marked degree are:

	Width of doublet.			
	Bismoclite		Daubreeite	
	Observed.	Calculated.	Observed.	Calculated.
(110) and (102)... ...	0·100	0·100	0·080	0·074 cm.
(211) and (104)... ...	0·104	0·097	not resolved	0·033
(105) and (220)... ...	not resolved	0·020	0·107	0·123

A probable explanation of the different cell-dimensions of the two minerals is to be sought in their chemical composition and therefore in their crystal-structure. Domeyko's original analysis of daubreeite corresponds fairly well with the formula BiO(OH,Cl), where the atomic proportions of hydroxyl and chlorine are nearly equal:

	Daubreeite.	BiO(OH,Cl).	BiOCl.
Bi_2O_3 ...	89·60	92·74	89·41
Cl	7·50	7·06	13·67
H_2O... ...	3·84	1·79	—
Fe_2O_3 ...	0·72	—	—
	101·66	101·59	103·08
Less O = Cl	1·69	1·59	3·08
	99·97	100·00	100·00

The possibility of Domeyko's analysis corresponding to a mixture of bismuth ochre and bismuth oxychloride has not been overlooked. Careful examination of long-exposure powder photographs of the specimen loaned by Professor Lacroix fails to reveal any lines which cannot be indexed on the daubreeite lattice.

Evidence from quite another direction also shows that the low orine figure obtained by Domeyko was not due wholly to im-ities. Mr. Hey has obtained precipitates of hydrated bismuth chloride by adding a large excess of ammonia to solutions of muth chloride. Powder photographs of a preparation containing y 10·25 % chlorine are identical with the daubreeite photographs not with those of bismuth oxychloride. Although no preparation h as low a content as 7·5 % chlorine has yet been made it is portant to note that Mr. Hey's syntheses are further evidence for existence of compounds of the type BiO(OH,Cl). It is possible t daubreeite represents the limit of basicity since no convincing of the existence of BiO(OH) as a mineral nor of its artificial paration has been offered.

TABLE 4. *Observed intensities and calculated structure-factors for powder photographs of bismoclite and daubreeite.*

ract-ane.	$\frac{\sin\theta}{\lambda}$ Bismo-clite.	$\frac{\sin\theta}{\lambda}$ Daubree-ite.	Observed intensity Bismo-clite.	Observed intensity Daubree-ite.	Structure-factor S' Bismo-clite.	Structure-factor S' Daubree-ite.
01)	0·068	0·068	m	m	37·4	37·7
02)	0·136	0·135	w	w	−37·8	−40·0
00)	0·182	0·184	ms	ms	76·5	73·4
02)	0·187	0·188	s	s	70·4	65·3
03)	0·204	0·203	mw	w	−52·0	−54·2
11)	0·295	0·298	m	s	44·8	48·0
04)	0·300	0·300	ms		−59·9	−60·4
12)	0·318	0·320	s	ms	58·2	53·7
03)	0·328	0·330	m	w	−49·0	−47·6
05)	0·339	0·338	nil	nil	38·1	43·8
05)	0·363	0·362	m	w	−35·3	−33·3
20)	0·364	0·367		w	56·8	64·1
14)	0·396	0·397	m	m	−52·7	−52·6
10)	0·407	0·411	m	w	57·3	60·1
06)	0·407	0·406		w	60·2	53·4
23)	0·417	0·420	w	vw	−39·6	−42·6

e table 2, p. 52, for intensity symbols, &c.; cf. p. 53, for low intensities of (00*l*).

t might be expected that intensity data from powder photographs ld reveal whether the crystal-structure of daubreeite differs from of bismoclite in the random replacement of about one-half the orine by hydroxyl ions. A slight change in the parameter of the muth ion, however, from 0·171 to 0·175 must also be included in calculation of structure-factors, and the final result is that very

little difference exists between either the observed intensities or calculated structure-factors (table 4). X-ray work, therefore, is not inconsistent with the possible isomorphous replacement of chlorine by hydroxyl ions.

The distinction between bismoclite and daubreeite, owing to the lack of suitable material for a new analysis of daubreeite, is dependent upon the X-ray identification of artificial hydrated bismuth oxychloride, low in chlorine, with daubreeite, the difference in cell-dimensions of the two minerals, and finally upon Domeyko's original analysis.

Two new bismuth minerals from South Africa.

By Edgar D. Mountain, M.A.
Professor of Geology in Rhodes University College,
Grahamstown, South Africa.

[Read March 14, 1935.]

Bismoclite from Steinkopf, Namaqualand, Cape Province.

A SMALL specimen (McGregor Museum, no. 4465) labelled 'Bismuth ore' was sent to me in 1932 by Miss M. Wilman, Curator the McGregor Museum, Kimberley, for identification. It had been sented to the Museum by Mr. M. Caplan, a store-keeper of Steinpf. The majority of bismuth-bearing minerals from Namaqualand me from a number of spots in the neighbourhood of the water-hole wn as Jackals Water, which is situated 18 miles NNE. of the lage of Steinkopf. Reference has already been made to this lity in a previous paper.[1] The exact locality of this specimen is egmatite outcrop in granite-gneiss about a mile and a half south the Noumaas trigonometrical beacon which is situated some 13 es north-west of Jackals Water to the west of the Viool's Drift d. The specimen was picked up on the surface, being obviously of vial origin. A few tons of bismuth-ore were subsequently reved from this locality by Mr. Caplan, but the greater part of this terial was yellowish and greenish in colour and presumably conted of bismutite.

The specimen was originally only $2 \times 1 \times 0{\cdot}5$ inches in size, weighabout 65 grams, and appeared to consist largely of the one neral associated only with flakes, up to half an inch across, of a ery mica, which on examination proved to be muscovite, and ch was to some extent intergrown with the main mineral, though stly occurring at the surface. The surface of the specimen was gely covered over with a dark grey discoloration, but where ently fractured the material was seen to be of a creamy white our.

[1] E. D. Mountain, Pegmatites of the Cape Province. Rec. Albany Museum, hamstown, 1931, vol. 4, p. 128. [Min. Abstr., 4–475.]

Small pieces of the specimen were broken off and carefully examined. The new surfaces were pale greyish or creamy-white in colour, and very nearly homogeneous, being slightly yellowish in patches and penetrated by occasional very narrow veins of a somewhat darker grey material. The bulk of the material is very obviously crystalline in character, being columnar or platy-fibrous. The elongated, scaly crystal-individuals possess at least one well-defined cleavage parallel to their length which shows a pearly lustre, while the mass as a whole shows a somewhat greasy or silky lustre. It appears as if the darker veins consist of the same mineral in a more granular condition. Under the microscope, crushed fragments show no characteristic shape owing to their softness and are absolutely opaque. The hardness is $2\frac{1}{2}$ and the specific gravity determined by pyknometer on 3 grams of finely powdered and purified material was 7·36 at 27° C., determinations in duplicate on different samples giving almost identical results.[1]

When gently heated in the closed tube a small quantity of moisture is given off which shows a strong acid reaction to methyl orange, while the powder becomes dark grey on the surface. On further heating it again becomes almost white and then yellow, at the same time yielding a white, cloudy sublimate. At higher temperatures the colour darkens to orange and the sublimate collects into lemon-yellow globules. Finally, the substance melts on becoming red-hot and on cooling solidifies to a lemon-yellow mass. In the open tube the behaviour is similar except that the sublimate is a dense white and does not collect into yellow globules. The mineral also gives typical reactions for bismuth and chlorine. It gives an indistinct pale-blue colour to the flame similar to that given by lead. It is completely soluble without effervescence in acids but is precipitated on considerable dilution. It dissolves in concentrated hydrochloric acid to a pale brownish-yellow solution, and in concentrated nitric acid to an almost colourless solution.

For a chemical analysis separate portions were used for determining water, bismuth, and chlorine. One portion was used to determine loss of weight on heating to 110°, 150°, 200°, and 250° C., and showed that the bulk of the combined water was released between 200° and 250° C., when a slight blackening of the powder took place. A second portion was used to determine the combined water by the direct method on ignition; great care was taken to prevent sublima

[1] Compare value 7·717 for artificial BiOCl (this vol., p. 51).

n, but no attempt was made to determine the amount of acid
: water contained in view of the small quantities concerned. Bis-
tth was determined as BiOCl and chlorine as AgCl. The following
ures under column I are the results of the analysis, and the figures
ller column II represent the theoretical composition of bismuth
ychloride BiOCl for comparison. It is clear that the composition of
: mineral approaches very closely to that of the oxychloride.

	I.		II.
Bi_2O_3	88·49	...	89·41
Fe_2O_3	0·12	...	—
PbO	trace	...	—
Cl	13·00	...	13·67
H_2O+ (above 110° C.)	0·45	...	—
H_2O- (below 110° C.)	0·42	...	—
Insoluble	0·77	...	—
	103·25	...	103·08
Less O = Cl	2·93	...	3·08
	100·32	...	100·00

The composition and properties of the mineral bear some resem-
nce to daubreeite as given in Dana's 'System of Mineralogy'.
r this reason I took the specimen to the British Museum (Natural
story) in London for comparison. Mr. F. A. Bannister kindly
mined the mineral by X-ray methods and has informed me that
s identical with the artificial compound BiOCl which crystallizes
the tetragonal system and which he has recently described before
s Society (this vol., p. 49). He has also made a study of specimens
daubreeite kindly loaned by Professor A. Lacroix and has found
all but definite differences in cell-dimensions and atomic positions
tween the two minerals. The distinction on chemical grounds is
n more certain. The original analysis of daubreeite shows a
lorine content of 7·5 %, whereas the figure for BiOCl should be
·67 %. The South African material, which is almost anhydrous,
ntains 13 % chlorine, and gives powder photographs exactly
ntical with those of artificial BiOCl, cannot, therefore, be identi-
l with daubreeite. Mr. Bannister has suggested the name bismo-
te in reference to its composition, and I propose to adopt this
a very suitable name.

I have examined a number of specimens of bismuth-ore from th
ckals Water localities presented to the Albany Museum, mostly by
. Redmond Orpen and Major Leipoldt, but I have found nothing
ite identical with this bismoclite. Several specimens with a rolled

or water-worn appearance and blackened surface appear on being broken to be identical, but when tested are found to contain besides bismuth and chlorine at least some quantity of carbon dioxide and what appears to be more than 1 % of water. One specimen is dark grey throughout, though similar in texture, and on testing chemically was found to contain, in addition to bismuth and chlorine, appreciable amounts of copper, carbon dioxide, and water. This specimen also contains quartz and chrysocolla. From rough qualitative tests other bismuth minerals occurring in these ores are hydroxide, carbonate, and hydrous carbonate, but they are ill-defined and indistinguishable with certainty without chemical tests. Most of the material would appear to come into the species-category of bismutite, but some of it might repay further qualitative examination.

Most of these specimens are of a pegmatitic nature consisting chiefly of quartz, orthoclase, albite, and muscovite with occasional brown garnets, some of the specimens being brightly coloured with small quantities of green copper minerals. None of the felspar examined under the microscope showed the twinning characteristic of microcline. Other specimens consist of garnetiferous granite and biotite segregations, probably from schists, with bismuth-ochre disseminated. Incidentally, it might be mentioned that the specimen of bismoclite described contains the minutest trace of copper. The bismuth minerals appear to be of later origin than the orthoclase, in part replacing it, and are most intimately associated with the muscovite of pegmatite and greisen.

Boksputite from Boksput, Langklip, Gordonia, Cape Province.

The farm Boksput, part of a large area leased to private individuals by the Government and situated in the north-east angle at the confluence of the Bak and Orange rivers, is a highly mineralized area. Horizontal beds of the Zwartmodder Series have been eroded through in this highly dissected region exposing a wonderful variety of igneous and metamorphic rocks and minerals. I have elsewhere described a number of minerals from this area (loc. cit., p. 122), but I have since received specimens of a new mineral from the occupant of the farm, Mr. A. Marsh. The specimens come from quartz-veins and pegmatites, and similar material has been collected as far east as the Molopo river and to the west beyond the border of South-West Africa. According to Mr. Marsh it occurs in quartz-veins in association with wolframite, scheelite, and beryl. It was said to contain

anium and lead, and indeed the colour very much resembles that of ne of the amorphous uranium-bearing pseudomorphs after urani-e, but on testing it was not found to be radioactive.

In the specimens the mineral occurs intimately associated with artz which is mostly very coarse-grained vein-quartz, highly nted, and in parts honeycombed with cavities partly filled with nonite. The quartz also contains rare small flakes of muscovite. e substance which forms the greater part of the specimens is in neral of a pale-yellow colour with a more or less earthy lustre. places this colour passes into a greyish-brown, at the same time ociated with a somewhat greasy lustre, and in patches the sub-nce becomes iron-grey in colour with a sub-metallic lustre. casionally within these latter patches, and only there, are to be nd small inclusions, scarcely visible without a lens, of native bis-uth. The specimens also are locally stained green in minute tches by traces of copper.

Much of the yellow material is distinctly crystalline, being fine-ined with a slightly pearly lustre, apparently due to a cleavage a scaly habit. About 10 grams were isolated, powdered, and amined. On gently heating in a closed tube the powder decrepi-es slightly and gives off a small amount of moisture. On further ating it first becomes orange, then brown, and begins to melt ow red-heat to a blackish melt which solidifies on cooling to a llowish-brown mass. Where the mass creeps up the side of the e the colour of the thin film is lemon-yellow. In the open tube behaviour is identical. Strongly heated alone on charcoal it ily melts, giving a yellow sublimate near the assay and passing o white farther away. At the same time metallic beads are formed ich are soft and malleable and mark paper. When heated with tassium iodide and sulphur an orange sublimate is formed near the ay, passing into a brilliant red farther away, indicating the presence bismuth and possibly of lead. The flame tests give a very distinct d reaction, quite different from that of typical bismuth minerals. is soluble with effervescence in both hydrochloric and nitric acids, ing off carbon dioxide. The solution in concentrated hydrochloric d is greenish-yellow in colour, that in nitric acid almost colourless. hen 50% dilute sulphuric acid and alcohol are added to a ghtly dilute nitric acid solution a white precipitate forms and tles after a few minutes, indicating the presence of lead and arly distinguishing the mineral from bismutite.

The hardness is $3\frac{1}{2}$ and the specific gravity determined on 3 grams at 28° C. is 7·29. Under the microscope it is opaque in crushed fragments. A chemical analysis gave the results under column I. The determinations of lead and carbon dioxide were made in duplicate on portions of the same powder and gave substantial agreement.

	I.		II.
PbO	67·22	...	69·13
Bi_2O_3	22·92	...	24·05
CO_2	6·96	...	6·82
Cl	0·99	...	—
H_2O+	0·73	...	—
H_2O-	0·19	...	—
Insoluble	0·34	...	—
	99·35	...	100·00
Less O = Cl	0·22		
	99·13		

Under II is given the composition corresponding to the formula $6PbO.Bi_2O_3.3CO_2$. The analysis agrees fairly well with these figures and suggests this fairly simple ratio between the chief constituents. Had there been no such simple relation I should have hesitated to describe the material as a mineral species. The mineral in general bears some resemblance on the one hand to massicot and on the other to the bismuth carbonates, bismutosphaerite and bismutite, but the $CO_2 : Bi_2O_3$ ratio is much too high in the mineral to regard it as a possible mixture of these minerals. The variations in colour and lustre are similar to those exhibited by the bismuth carbonates and would appear to be the result of different conditions of crystallization. Indeed, the mineral might possibly be regarded as a variety of bismutite in which the bismuth is very largely replaced by lead, especially when we bear in mind the very vague and variable composition of the material which is given that name.

Mr. F. A. Bannister has kindly examined some of the material by X-ray methods. Two fragments from different parts of the same specimen yielded identical powder photographs. These, however, are rich in lines and have not been identified with the powder photograph of any known mineral.

It is proposed to call the new mineral boksputite after the locality. The name Boksput is a typical South African farm name meaning a well for goats, or possibly for wild buck.

Ankerites of the Northumberland coal-field.

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[Read January 24, 1935.]

THE first recognition of ankerite as a British mineral seems to have been made a little over fifty years ago by M. F. Heddle,[1] who described and analysed a sample from the Ting of Norwick, Unst. The occurrence of the mineral in veins in the Carboniferous limestone of Lilleshall, Shropshire, was recorded by C. J. Woodward,[2] who gives analyses of two specimens. T. Crook[3] noted the frequent occurrence of the mineral in British coal-fields and described specimens, with two analyses, from Lancashire, Yorkshire, Nottinghamshire, Leicestershire, and South Wales. F. S. Sinnatt[4] and his collaborators, in their work on the mineral constituents of coal, have paid a good deal of attention to the 'white partings' or ankerites, which, as they say, 'no study has appeared in the literature'. Three complete analyses were made of specimens from the Lancashire coal-field; no specific gravities are recorded. Incidental reference to the subject is made in a later paper by F. S. Sinnatt[5] and also by H. Briggs[6] in a paper on the X-ray examination of coal.

So far as we are aware, there is no published information about the ankerites of the Northumberland coal-field. Our attention was first drawn to the subject during the course of an investigation on the heavy minerals in the stream-sands of the north of England by finding that the Hartley Burn yielded a sand abounding in ankerite. This burn is greatly polluted by the sludge from several coal-washeries

[1] M. F. Heddle, Min. Mag., 1878, vol. 2, p. 20.
[2] C. J. Woodward, Quart. Journ. Geol. Soc. London, 1883, vol. 39, p. 466.
[3] T. Crook, Min. Mag., 1912, vol. 16, p. 219.
[4] F. S. Sinnatt, A. Grounds, and F. Bailey, Journ. Soc. Chem. Ind., 1921, 140, p. 1.
[5] F. S. Sinnatt and N. Simpkin, Journ. Soc. Chem. Ind., 1922, vol. 41, p. 167. F. Sinnatt and H. E. Mitton, Inst. Min. Eng., 1924, vol. 67, p. 486.
[6] H. Briggs, Inst. Min. Eng., 1928–1929, vol. 77, p. 5.

about Cramlington, so that the source of the ankerite is apparent. In our further study we have examined material from the coal-washing plants at Cramlington and Ashington, also samples selected from two pits in the neighbourhood, and finally one of us (J. A. S.) has been fortunate enough to find veins of the mineral in the Coal Measures on the coast at Hartley.

Great care was taken in the purification of the raw materials used in this work. After hand-picking, where possible, the mineral was crushed and sized, and the fraction 60–80-inch mesh thoroughly washed or sometimes elutriated. The chief constituents (with specific gravities) are pyrite (5), ankerite (3), calcite (2·72), quartz (2·65), with shale and coal. To separate these bromoform (sp. gr. 2·8) and mixtures of bromoform and chloroform were employed. Attempts to separate pyrite and ankerite by froth-floatation were unsuccessful, but they can be separated electromagnetically. Some details of the origin and treatment of the samples are given below.

A. Sand from the Hartley Burn, Holywell Dene. This is black and slimy from the coal and shale which it contains and is very difficult to handle. The fraction under 80-inch mesh was elutriated and treated systematically with bromoform and electromagnetically. The heavy fraction was very rich in pyrite and contained, in addition, the minerals of the sand proper, viz. garnet, zircon, rutile, tourmaline, apatite, augite, and baryte. As some of these are electromagnetic they are inseparable from the ankerite, hence the rather high value for 'insoluble' in the analysis.

From information received from Mr. T. Rose it appears that effluent waters from the coal-washeries at the Burradon, Backworth, and East Cramlington collieries are drained into the Hartley Burn. Through his kindness and that of Mr. E. Jones, chief chemist at East Cramlington (Hartley Main Company), we received samples of sediment from the effluent water and of pond-duff from the settling ponds, and this material, after suitable treatment, yielded ankerite (FeO, 12·9 %) identical with that isolated from the burn sands several miles lower down. Seven seams are being mined at this colliery, but the bulk of the coals washed comes from the Main, Yard and Low Main seams. The pyritic concentrate from this material contained some zinc-blende.

B. Rejects from the cleaning of duff in a Rheolaveur washer at Ashington. We are indebted to Dr. A. Crawford of the Ashington Coal Company for a sample of this material. The coals washed are

e High Main, Main, Yard, Five Quarter, and Low Main. The ction 60–80-inch mesh from which the ankerite was obtained ntained ankerite 30 %, pyrite 24 %, shale and coal 41 %, quartz 5 %. ere was a little zinc-blende and calcite present along with some ttallic iron from the plant.

C. On the coast at Hartley, just south of the first headland, one-rd of a mile north of St. Mary's Island, there is a section in the ffs bounded by two small faults, showing 8 feet of sandstone over-n by two coal seams and their accompanying shales. The horizon the coals is doubtful. Two irregular and almost vertical veins, th a maximum width of two inches, cut this sandstone. They are ched out in the overlying shale and their relation to the coals not be determined owing to the slipped condition of the soft beds. e more northerly vein is of massive brown-coloured ankerite, ctically free from pyrite, but somewhat contaminated at the eeks with sandstone. The hand-picked material proved to be very re; it was dressed in the usual manner, mixtures of bromoform l chloroform being used for the gravity separation.

D. The more southerly of the two veins just mentioned is white l yields on occasion good crystals of calcite (nail-head spar). It ssociated with a small amount of pyrite which contains strong ces of copper and nickel.

The two faults in the cliff are traceable on the foreshore; they r 65° east of north (magnetic). Though barren in the cliff they w infillings on the shore, the vein (G) in one place being four hes wide and consisting of ankerite with a core of calcite and ite. The microscopic examination of this will be described later. ere is also a stout ankerite vein (H) close to and parallel to this. tween these two faults and almost at right angles to them (bearing ° west of north) there are at least nine parallel veins, seven of kerite and two of calcite. Four of the former (I to L) are from ee to six inches wide, the remainder being thin strings. Samples these veins, without purification beyond that of hand-picking, shing, and washing, prove to be of ankerite similar in composition the material C, as shown by the following determinations:

	Sp. gr.	FeO %.	$FeCO_3$ (calcd.).
H	2·96	12·39	20·12
I	2·96	12·43	20·22
J	2·97	13·07	21·24
K	2·97	13·63	22·18
L	2·98	15·02	24·42

E. The raw material for this consisted of white partings, kindly supplied by Mr. H. Berry, M.Sc., of the Coal Survey, Armstrong College, who gathered it from the cleats of the coal of the Beaumont seam in Burradon colliery. It contained a fair amount of pyrite.

F. We are again indebted to Dr. A. Crawford for this material, which was in the form of large and strikingly beautiful hand-specimens. It is from the High Main seam in Bothal pit and occurs locally in considerable quantity, in bands and layers up to three inches thick, roughly parallel to the bedding of the coal. The material is snow-white and massive, bordered by coal with, frequently, an intervening band of pyrite. It was prepared for analysis as in D and E.

In the following table are given the analyses of these purified minerals. Sulphate is absent in all cases ; A, B, and C contain strong traces of chloride which is absent from the others. Insoluble matter, except in the case of A which has already been commented on, consists chiefly of the minute crystals of pyrite enclosed within the grains of the carbonate mineral. The carbonate contents are calculated from the oxides of the bivalent metals, and we also give the calculated compositions as double carbonates.

Analyses of ankerites and ankeritic calcites.

		A.	B.	C.	D.	E.	F.
Sol. in dil. HCl	SiO_2 ...	0·10	trace	n.d.	n.d.	n.d.	n.d.
	Al_2O_3 ...	1·90	0·80	0·83	0·28	0·19	0·20
	Fe_2O_3 ...	0·61	0·08				
	FeO ...	12·53	13·04	13·54	0·56	0·35	0·76
	MnO ...	0·61	0·75	0·75	0·22	0·37	0·35
	MgO ...	9·98	11·02	11·45	0·24	0·26	0·27
	CaO ...	26·62	27·94	29·15	55·40	55·00	54·75
	CO_2 ...	39·65	42·40	43·50	43·50	43·42	43·70
	Insol. ...	7·80	3·75	0·80	nil	0·45	nil
		99·80	99·78	100·02	100·20	100·04	100·03
	$d\frac{t^\circ}{4^\circ}$ ...	3·036	2·996	3·008	2·721	2·719	2·727
$FeCO_3$		22·56	22·10	22·06	0·89	0·56	1·21
$MnCO_3$		1·10	1·27	1·22	0·36	0·60	0·57
$MgCO_3$		23·30	24·21	24·17	0·50	0·54	0·56
$CaCO_3$		53·04	52·42	52·55	98·25	98·30	97·66
		100·00	100·00	100·00	100·00	100·00	100·00
$FeCO_3.CaCO_3$ ...		42·04	41·18	41·11	1·66	1·04	2·26
$MnCO_3.CaCO_3$ ...		2·05	2·37	2·28	0·67	1·12	1·06
$MgCO_3.CaCO_3$ ...		50·94	52·92	52·83	1·09	1·18	1·22
$CaCO_3$		4·97	3·53	3·78	96·58	96·66	95·46
		100·00	100·00	100·00	100·00	100·00	100·00

The ankerite is white or light brown in colour and electromagnetic; the ankeritic calcite is white and non-electromagnetic. The refractive index of the ordinary ray for the ankerite was determined by immersion of the powders in mixtures of methylene iodide and bromonaphthalene. Slight variations in the indices of the different grains are observed in each sample, there being a tendency for the rarer clear grains to show a higher index than the more abundant turbid ones. Samples A and B varied from 1·703 to 1·717, corresponding to differences of ferrodolomite content of 16 % (estimated from fig. 2). For sample C the extreme values were 1·708 and 1·713, the majority of the grains being about 1·711, and we adopt the value of $1{\cdot}711 \pm 0{\cdot}001$ as the average. The ankeritic calcite F gave ω $1{\cdot}6615 \pm 0{\cdot}0005$ (for pure calcite 1·6584).

These optical data prove that in our samples none of the carbonates or double carbonates is present individually, but that all are in solid solution. In the preliminary work it was found useful to test for calcite by mounting the powders and thin sections in piperine (ω 1·68). Owing to the strong dispersion every ankerite grain exhibits alternately, on rotation above one nicol, blue-green (ordinary ray) and yellow borders, whereas the calcite shows yellow borders only, making the rapid detection of any calcite grains an easy matter.

The nature of ankerite has been the subject of much discussion. The published analyses show great variation, even when due allowance is made for impurity of material and analytical imperfections. From the tendency to constancy in calcium carbonate content and the consequent sympathetic relation between the carbonates of iron and magnesium, C. Doelter [1] argued that, in the main, ankerites are isomorphous mixtures of dolomite $MgCO_3.CaCO_3$ and ferrodolomite $FeCO_3.CaCO_3$, with small amounts of mangandolomite $MnCO_3.CaCO_3$.

In fig. 1 we have plotted the compositions (carbonates recalculated to 100 %) of all those carbonate minerals, published in Doelter and current literature (totalling about 180), which have calcium carbonate contents between 45 % and 65 %—the iron and manganese carbonates being taken together. The general clustering about the line representing mixtures of $MgCO_3.CaCO_3$ and $(Fe,Mn)CO_3.CaCO_3$ is evident, but the greater number of analyses show excess of calcium carbonate, whilst many show excess of magnesium or iron carbonate. In the absence of rigorous selection of material and of optical data it cannot

[1] C. Doelter, Handb. d. Mineralchem., 1912, vol. 1, p. 371.

be assumed that the excess of calcium carbonate is always in solid solution, and one may suspect the presence of calcite in some of the analysed samples, as ankerite and calcite commonly occur together. The maximum reported excess of calcium carbonate in an ankerite is 20·8 % for a 'dolomite' from Ouray, Colorado,[1] and the optical examination of this specimen[2] shows that this excess is present in solid solution. There are no optical data for those ankerites showing any notable excess of magnesium or iron carbonate and we cannot therefore be sure that these carbonates do occur in solid solution in ankerite.

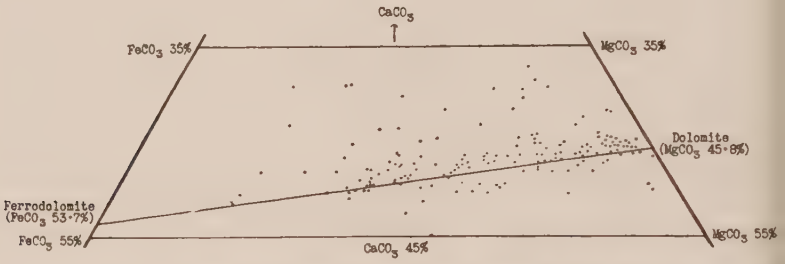

FIG. 1. Plot of analyses of carbonate minerals with $CaCO_3$ contents between 45 % and 65 %.

From various sources[3–8] we have collected optical data relating to thirty-two ankerites of known composition, and the values for the indices of the ordinary ray are plotted in fig. 2. The dots represent the indices of those ankerites which approximate closely in composition to mixtures of dolomite and ferrodolomite, viz. with excess of calcium, manganese, or magnesium carbonate of less than 1 %. The line drawn to fit the trend of these values gives the indices 1·679 for dolomite and 1·765 for ferrodolomite, this latter value being lower

[1] H. W. Foote and W. M. Bradley, Amer. Journ. Sci., 1914, ser. 4, vol. 37, p. 343.

[2] W. E. Ford, Trans. Conn. Acad. Arts and Sci., 1917, vol. 22, p. 243. [Min. Abstr., 1–10.]

[3] K. Eisenhuth, Zeits. Kryst. Min., 1902, vol. 35, p. 584.

[4] W. E. Ford, loc. cit.

[5] P. Gaubert, Bull. Soc. Franç. Min., 1919, vol. 42, p. 88. [M.A., 2–188.]

[6] P. Koller, Neues Jahrb. Min., 1919, Beil.-Bd. 42, p. 457. [M.A., 1–350.]

[7] T. Ulke, Amer. Min., 1933, vol. 18, p. 312. [M.A., 5–517.]

[8] A. De Klerk and V. Goldschmidt, Tschermaks Min. Petr. Mitt., 1925, vol. 38, p. 159. [M.A., 3–213.]

ıan the one (1·775) adopted by A. N. Winchell.[1] The crosses epresent the calculated indices of the other ankerites, being the ıeasured values corrected on the assumption that the excess of ılcium carbonate and the mangandolomite is present as dolomite

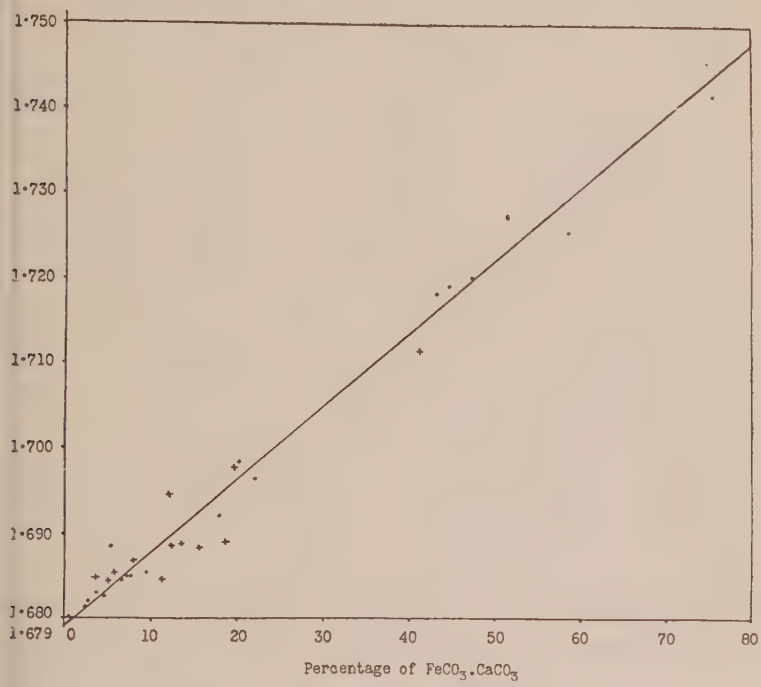

Fig. 2. Refractive indices (ordinary ray) for the $MgCO_3.CaCO_3$–$FeCO_3.CaCO_3$ ankerites.

ıd ferrodolomite respectively. The indices used in these calculaons are calcite 1·658, dolomite 1·679, ferrodolomite 1·765, mangandolomite 1·743. The distribution of the values is in conformity with ıat of the other ankerites. The departure shown by the indices om the straight line series is probably largely due to the nonmogeneity of the samples. Constancy of composition throughout ıy ankerite specimen is not to be expected—the Hartley ankerite ows a variation of 16 % in content of ferrodolomite, and we have general no guarantee that the indices reported are the average ılues which are wanted for correlation with the chemical analyses.

[1] A. N. Winchell, Elements of optical mineralogy, part 2, 3rd edit., 1933, 74.

In fig. 3 we give a diagram showing the relation between the ordinary ray indices and the composition of the ankerites, and this diagram is in closer agreement with the data than the one given by Winchell (loc. cit.).

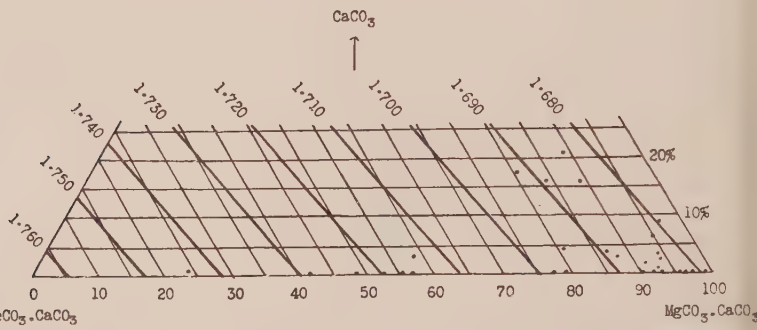

FIG. 3. Refractive indices (ordinary ray) for the $MgCO_3.CaCO_3$–$FeCO_3.CaCO_3$ ankerites with $CaCO_3$ in solid solution. The dots represent analysed specimens for which the indices have been determined.

The association of ankerite and ankeritic calcite is not unusual [1] and the relationship between the two minerals in our area has points of interest which merit further description. The group of veins on the coast at Hartley embraces three classes, viz. :

1. Ankerites, identical in composition with those derived from numerous coal seams at Cramlington and Ashington.

2. Ankeritic calcite, identical in composition with the mineral from the Beaumont seam at Burradon and the High Main seam at Bothal.

3. The minerals 1 and 2 occur in the same vein (G on the foreshore, mentioned under D, ante, p. 67).

In the last-mentioned case the calcite (carrying a fair amount of pyrite) occupies the middle of the vein and its dazzling whiteness marks it off sharply from the brown ankerite. Pieces of the two minerals, broken off from their contact, without purification of any kind, were found to contain 13·2 % and 0·9 % FeO, as against 13·5 % and 0·56 % for the purified minerals of the veins in the cliff section (C and D above). Polished surfaces of the material, when etched with dilute hydrochloric acid, show a sharp contact between the two minerals in places, though at times a band of pyrite separates them.

[1] H. W. Foote and W. M. Bradley, loc. cit.; A. De Klerk and V. Goldschmidt, loc. cit.; H. Louis, Proc. Nova Scotian Inst. Nat. Sci., 1882, vol. 5, p. 47.

Thin sections cut across the contact and mounted in piperine reveal a sharp demarcation of the ankerite from the ankeritic calcite, the crystallographic orientation of the two minerals being different (fig. 4); thus there is no overgrowth or compositional transition. A similar relation was observed by T. Crook (loc. cit., p. 221), who remarks: 'Occasionally, calcite and ankerite are seen in the same layer; but in such cases . . . there was a sharp line of demarcation between the calcite and the ankerite portions of the layer.' In the sample under investigation it is evident that the ankeritic calcite is later in age than the ankerite (see below). W. E. Ford (loc. cit., p. 244) has demonstrated by a plot of the analyses that there is a wide gap indicating limited miscibility between the ankerites with 30 % of calcium carbonate in solid solution and the ankeritic calcites. This is in harmony with our observations.

It is remarkable that in the portion of the coal-field which we have examined, the area of which is roughly a square, 6 × 6 miles in size, and which extends from the horizon of the High Main seam down to that of the Beaumont seam, we have only found evidence of these two ankeritic minerals. If this is confirmed by future work it can only mean that the area was invaded by ankeritic solutions of common origin, and it is legitimate to infer that the coal seams were fed from the vein fissures and that the time-succession of deposition of the two minerals accepted for the Hartley veins applies also to the coal seams.

Thin slices of the vein G under the microscope show anhedral ankerite and ankeritic calcite crystals averaging 3 mm. in diameter. Polysynthetic twinning is present in the outermost ankerites, the twin bands averaging 0·2 mm. in width, and the wavy extinction of the adjoining ankerites provides optical evidence of distortion. The junction of the ankerite with the central ankeritic calcite is a sharp, angular, and toothed one, the boundary corresponding to the cleavages in the ankerite and not of the calcite (fig. 4); further, angular ankerites are found within the calcite. It is thus clear that the ankeritic calcite was the later mineral to be deposited, and the evidence indicates that movement in and brecciation of the ankerite preceded the deposition of the calcite. It is of interest to observe that (although ankerite is absent in this case) the coal in the Bothal seam has been fissured and brecciated before the invasion of the calcite-bearing liquors. The brecciation is well shown in the micrograph of fig. 5.

The frequent association of pyrite with the coal ankerites and

especially its common occurrence as a fringe or border of the coal (fig. 5) suggest, on first consideration, that it may have originated by the reduction of sulphates, somewhat in the manner postulated by H. B. Stocks [1] in his work on coal-balls. The absence of sulphate in

Fig. 4.

Fig. 5.

Fig. 4. Thin section of Hartley vein. Darker mineral, ankerite; lighter, ankeritic calcite; black patches are turbid ankerite, with the exception of the one on the right, which is pyrite. $\times 7\frac{1}{2}$.

Fig. 5. Ankeritic calcite, Bothal pit. Black areas, brecciated coal; white, calcite; speckled, pyrite. Reflected light. $\times 11\frac{1}{2}$.

the minerals we have examined is, however, against this interpretation, and the phenomena of deposition are so entirely different in the two cases that similarity of origin is hardly to be expected. Further, pyrite is present in abundance in some of the Hartley veins, where reduction by carbonaceous matter can scarcely have taken place.

The question of oxidation of ankerite by atmospheric agencies has been raised by F. S. Sinnatt, A. Grounds, and F. Bailey (loc. cit.), but the experimental evidence submitted by them was inadequate to decide it. To test the matter a sample of the crude mineral from

[1] H. B. Stocks, Quart. Journ. Geol. Soc. London, 1902, vol. 58, p. 46.

ıe Hartley vein was finely ground and divided into three parts. ne part was sealed in a tube, another spread thinly in a dry con- ıtion, and the third part mixed into a paste with water, spread ver a large surface, and kept moist, with frequent stirring, for three onths. At the end of this time the last sample was allowed to dry ıd all three were then analysed. They were found to contain the me amount of ferrous iron (13·1 % FeO), so that no perceptible ıidation takes place under the specified conditions. On the other ınd, when the finely powdered ankerite is suspended in water and stream of carbon dioxide passed through, the mineral is speedily tacked; the bases pass into solution as bicarbonates and the rrous salt is rapidly oxidized by air to the hydrated ferric oxide.

Summary.

1. Ankerite and ankeritic calcite are described from veins in the al Measures on the coast at Hartley and from various seams in e Northumberland coal-field. Evidence is given that, in the portion the coal-field examined, both minerals are of constant composition, d that the deposition of the ankerite preceded that of the ankeritic lcite.

2. The ankerites are members of an isomorphous series consisting dolomite $MgCO_3.CaCO_3$ and ferrodolomite $FeCO_3.CaCO_3$, with all amounts of mangandolomite $MnCO_3.CaCO_3$, and they may hold to 20 % of $CaCO_3$ in solid solution.

3. The refractive indices (ordinary ray) of the ankerites are exam- ed, and the value deduced for $FeCO_3.CaCO_3$ is 1·765.

A new apparatus for the determination of carbon dioxide.

By Max H. Hey, M.A., B.Sc.

Assistant-Keeper in the Mineral Department of the British Museum of Natural History.

[Read January 24, 1935.]

As most analysts recognize, the method generally used for the determination of carbon dioxide present as carbonate, by decomposition with acid, absorption in soda-lime or soda-asbestos, and weighing as carbon dioxide, is open to several objections; and several suggestions have been made from time to time with the object of avoiding the use of absorption tubes,[1] but none of these have come into general use, generally because of inconvenience in manipulation.

The principal objection to the use of absorption tubes (apart from their general inconvenience and the numerous precautions their use entails) lies in the uncertainty of the blank correction; when a blank experiment is performed, under precisely the same conditions as the actual determination, a small gain in weight of the absorption tubes is almost invariably observed, but in a series of several blank experiments, this gain is frequently very variable, and by no means proportional to the volume of air drawn through the absorbers, unless many precautions are observed. Care must be taken that the air current which is to carry the carbon dioxide is adequately dried after leaving the evolution flask, and thoroughly freed from hydrochloric acid, chlorine, or hydrogen sulphide; further, the actual absorbent collecting the carbon dioxide is liable to lose water to the air-current[2] and must therefore be followed by an absorption tube containing the same absorbent as was used to dry the air-current before absorption of the carbon dioxide. The absorption tube is usually weighed against

[1] See, for example, the procedures referred to by W. F. Hillebrand and G. E. F. Lundell, Applied inorganic analysis. New York, 1929, p. 631, section D.

[2] Especially if soda-lime is used; this absorbent does not function efficiently if it is too dry.

similar tube as counterpoise, and hung in the balance case for some me to attain the same conditions of surface moisture as the counter- ›ise, since drying by heat is obviously inadmissible.

Even when a consistent blank is obtained this cannot be accepted unquestionably the true correction, for the absorption of the carbon oxide in the experiment proper will result in some heating of the ›sorption tube and change in the weight of air and moisture absorbed ı its surface, besides a change in buoyancy owing to expansion.[1] If ıe absorption tube is hung in the balance case for an adequate length time before weighing this error will be avoided, but it is evident ıat the time which was found adequate to attain consistent results a series of blank experiments will not be adequate in the actual ›termination owing to the slightly different conditions. In many ıses, the resultant error will be so small as to be safely neglected, ıt its existence should not be overlooked when determinations of ›ecial accuracy are sought.

In all the methods that have been proposed in which the use of ›sorption tubes is avoided the carbon dioxide is absorbed in baryta ›lution. The barium carbonate produced may be filtered off, dried, ıd weighed, or filtered off, dissolved in acid, and determined volu- ›trically or gravimetrically, or a measured volume of standard ›ryta may be used and the excess determined by titration or by ›nductivity methods. These procedures all do away with the ›cessity for drying the gas-stream, though the main bulk of the ›ter should be condensed. In the first two methods the gas-stream ›ed not be freed from hydrogen sulphide or hydrochloric acid;[2] ılphur dioxide will interfere, but is not often met with in mineral ıalysis.[3] The first two methods, however, involve filtration with ›clusion of air, which is in general a troublesome matter, and hence ›e third procedure has probably been the most used of these methods ›oiding the use of absorption tubes. A determination of the unused ›ryta by conductivity methods is especially attractive where the ›cessary apparatus is available, for the electrodes can be fitted in ›e absorption vessel itself and all exposure to the atmosphere

[1] See, for example, J. J. Manley, in Sir Edward Thorpe, Dictionary of applied ›emistry. London, 1921, vol. 1, pp. 521–522, sections 12 and 13.

[2] Sulphuric acid or sulphur trioxide may be present in the gas-stream if ›rbon is being determined by wet combustion; this will interfere in the first, ›t not in the second, procedure.

[3] Except in the determination of free carbon or organic matter by direct ›mbustion, should sulphides or sulphates be present.

avoided. It is also a fairly simple matter to conduct the titration with exclusion of air. The use of standard baryta solution, however, is liable to lead to difficulties, owing to the solvent action of such solutions on glass; J. Lindner[1] has shown that the amount of silica dissolved in a few days may be very considerable and can lead to considerable errors, proportionately larger with weaker solutions. To obtain accurate results the baryta solution is best freshly prepared for each analysis. The solvent action of baryta solution on glass may also lead to errors in the first two methods described, as the barium carbonate precipitate is liable to carry down barium silicate which had been in colloidal solution.

With suitable precautions the determination by absorption in standard baryta and back-titration (or conductometric determination) can be made very satisfactory, but it is not really suitable for very large or very small amounts of carbon dioxide. The apparatus now to be described is designed to overcome the difficulties of filtration with exclusion of air and so render the gravimetric determination as $BaCO_3$ or as $BaSO_4$ practicable. It depends essentially on the fact that so long as an air-current is being passed upwards through a porous filter-plate liquid will not flow down through it. The high absorption efficiency of a gas-washing apparatus in which the gas-stream is thoroughly subdivided by the use of a porous plate is also utilized.

The decomposition flask *A* (fig. 1) is provided with a three-hole stopper, carrying a tap-funnel *B*, and an inlet tube *C*, preferably provided with a tap; a small condenser is fitted in the third hole of the stopper, and from the upper end of this connexion is made directly to a small wash-bottle[2] *D*, of a form which can be shut off at pleasure. The wash-bottle *D* has a capacity of at least 40 to 50 c.c., and an internal height of at least 8 cm., preferably 10 to 12 cm.; with a smaller bottle some of the precipitate may be carried over into the connecting-tubes and occasion errors. From the wash-bottle the air-current passes through a small test-tube with side-tube *E*, and upwards through the sintered glass plate of a glass filter-funnel *F* having a filter-plate 20 to 25 mm. across set in a tube at least 10 cm.

[1] J. Lindner, Zeits. Anal. Chem., 1933, vol. 95, p. 1.

[2] The form of wash-bottle described by the author (Min. Mag., 1933, vol. 23, p. 386) is most convenient for this purpose, but the glass spiral must be omitted as it ceases to function when the carbonate precipitate becomes bulky, and even leads to splashing and loss.

better, 12 to 15 cm. long; the narrow stem below the filter-plate ...d not exceed 5 cm. in length; it should dip right to the bottom ...the tube *E*, lest a pocket of carbon dioxide be left, while the side-...e of *E* should be well up to the top. The funnel *F* is closed by

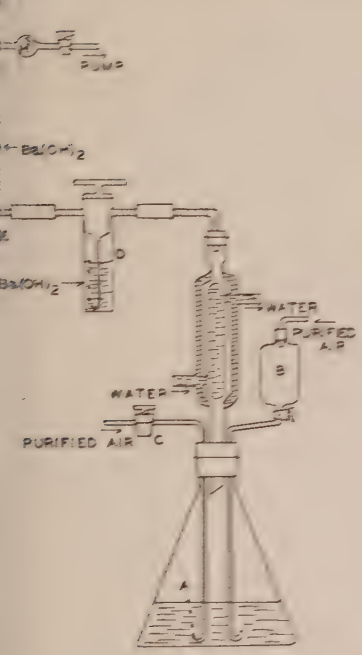

FIG. 1.

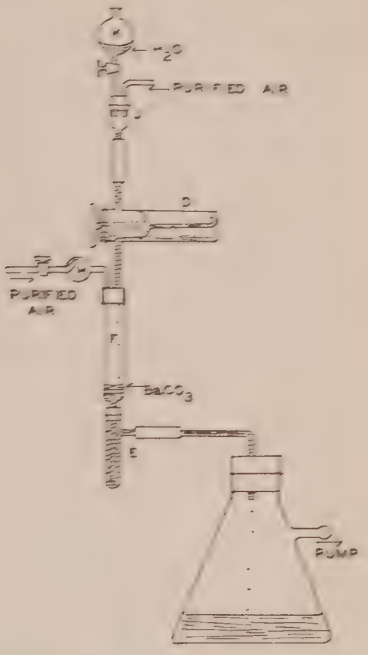

FIG. 2.

Apparatus for determination of carbon dioxide.

...ubber stop-cap (a stopper is less suitable, not being flexible), ...rying a small tap-funnel *G* and a connecting-tube with splash-...b and tap *H*. The connexions between *D* and *E* are made with ...ut pressure tubing, as thin rubber is not quite gas-tight to carbon ...oxide; mercury seals might also be used.

The procedure in use is as follows: the weighed portion of material[1] ...ving been placed in *A*, along with a proper amount of water, and ... air displaced by a stream of purified CO_2-free air, about $\frac{1}{2}$ to ...gram of $Ba(OH)_2.8H_2O$ (depending on the amount of CO_2 to be

[1] This should not contain more than about 0·10 to 0·15 gm. carbon dioxide. ...ess a larger wash-bottle is used at *D*.

collected) is roughly weighed out, dissolved in about 10 to 15 c.c of hot water, and filtered direct into the wash-bottle D; a second portion of about $\frac{1}{4}$ to $\frac{1}{2}$ gram baryta is dissolved in about 10 c.c. of water and filtered into the tap-funnel G. The exit-tube H is connected to the vacuum pump and a fairly rapid current of CO_2-free air drawn through the apparatus; now the top of the funnel G is opened and baryta allowed to flow slowly into the funnel F (there is no need to remove the stopper of G); bubbles should rise freely from all parts of the filter-plate, and the air-current, while considerably checked, should not be too greatly slowed; four bubbles a second may safely rise from the tube of the wash-bottle D, this rapid rate being permissible owing to the high efficiency of absorption in the funnel F. The air-stream may be allowed to pass for some time to check the efficiency of the purifying train if this is in any doubt; no opalescence or precipitate whatever should be produced in D or F after 1 or even $1\frac{1}{2}$ hours at the above rate, and a blank experiment should not show any weighable amount of barium carbonate formed. Acid is now added through the funnel B, and presently the evolution flask is heated as usual. The main part of the carbon dioxide is absorbed in D, but some passes on and is collected in F; as barium carbonate precipitates in F it gradually chokes the pores of the filter-plate and in order to keep up the speed of the air-current, the vacuum has to be increased;[1] the air-current must not be allowed to stop or the plate in F becomes wetted and the current cannot then be started again, or only with difficulty.

When the carbonate has been wholly decomposed and the carbon dioxide all carried forward by the air-stream the tap of wash-bottle D is closed, then the tap of H; D is disconnected, and the side-tube of the small tube E is connected by a bent tube to a 200 c.c. filtering flask; H is disconnected from the vacuum pump, which is connected to the filtering-flask, while H is connected instead to the air-purifying train. It is now a simple matter to filter off the barium carbonate precipitate in the funnel F and wash it with water introduced through G, while totally excluding atmospheric carbon dioxide. This done the stop-cap on F is detached and any splashes on its inside, or into the splash-trap of H, are quickly washed into F with a little water

[1] It is solely for this reason that the wash-bottle D is interpolated to collect most of the CO_2; if it is known that the material being used does not contain more than about 10 mg. of CO_2, D may be omitted and the CO_2 collected wholly in F, greatly simplifying the subsequent procedure.

tered off, and washed once or twice. Then the tap-funnel G is removed, nd the wash-bottle D inserted in its place; on replacing the stop- p the bottle D will be on its side (fig. 2). There is no danger from mospheric carbon dioxide during this interchange, since the barium rbonate in F has already been washed free from baryta, and D re- ains safely closed. The other side-tube of D can now be connected a small adaptor J, with a two-hole stopper carrying a tap-funnel and a connexion to the purified air supply. On starting the vacuum mp, with the tap of H closed and D opened, the liquid and preci- tate in D can readily be transferred to F, and rinsed out and washed ith water introduced through K, with total exclusion of atmo- heric carbon dioxide. The flexibility of the stop-cap on F greatly sists in the rinsing out of the precipitate; if a stop-cap is not ailable the rubber connexions between D and J and between E and e filter flask should be made fairly long, so that D and F can inclined slightly and gently shaken without disconnexion at any int.

The washed barium carbonate in F can now be dried and weighed such,[1] or dissolved in acid on the funnel for precipitation as $BaSO_4$; e latter course should, of course, be adopted if there is any possi- lity of the barium carbonate containing sulphate (sulphites would oxidized to sulphate by the air-stream in the alkaline solution). certain amount of barium carbonate always remains adherent to e inside of wash-bottle D, and there may be traces inside the stop- p fitted to F and in the splash-bulb of H; all these are rinsed out th a little acid, and their barium content precipitated as sulphate, ered off on a small filter,[2] ignited, and weighed.

With such minerals as scapolite decomposition by hydrochloric d is always imperfect, and L. H. Borgström[3] proposed to employ mixture of hydrofluoric and hydrochloric acids for their decom- sition (a glass flask can still be used, but of course will not last

Although the area of the glass filter-funnel F is as great as that of an orption tube the errors due to absorbed air and moisture are much less, ce the funnel is dried in an oven and cooled in a desiccator; if allowed to nd at least $\frac{3}{4}$ to 1 hour in the desiccator the weight of such a funnel remains stant to 0·1 or 0·2 mg. during several dryings and weighings. The effec- e error is further reduced by the large factor $BaCO_3$ or $BaSO_4 : CO_2$. But the highest accuracy solution and precipitation as $BaSO_4$ is probably pre- ble.

But little washing will be needed as there will be no foreign salts present.

L. H. Borgström, Zeits. Anal. Chem., 1914, vol. 53, p. 685.

for many experiments). With this addition there will, of course, be a possibility of hydrofluoric acid passing forward to the absorption bubbler or tubes,[1] and this will be counted as carbon dioxide whatever method is used, since barium fluoride is insoluble in water and baryta solution, but soluble in acid. Borgström failed to find any definite evidence of hydrofluoric acid reaching the absorption tubes, but his blank correction was rather large and somewhat irregular, so that traces might have been missed. The author has tested the matter, and finds that with 6 to 8 c.c. of strong hydrofluoric acid in a total volume of 100 c.c. liquid there are sometimes traces of fluorine carried forward, but often the condenser retains the whole. It will, however, be advisable, when hydrofluoric acid is used to facilitate the attack on refractory carbonate-bearing minerals, to dissolve the barium carbonate, plus any barium fluoride, in acid and precipitate as $BaSO_4$; in the filtrate the fluorine is then determined colorimetrically and a correction made.

As already mentioned, if not more than about 10 mg. of carbon dioxide is to be collected the wash-bottle *D* is omitted and the whole of the carbon dioxide collected in *F*. If the carbon dioxide to be collected is still smaller in amount the funnel *F* and the whole apparatus may be decreased in size, and 1 mg. or even 2 mg. of carbon dioxide may be successfully collected in 1 c.c. of baryta in a funnel 3 cm. high above the filter-plate, with a 1 cm. filter-plate, provided care is taken with the regulation of the air-stream. The method is thus available for micro-analysis.[2] It will also be evident that a similar arrangement can be adapted for the determination of carbon dioxide in air.

In order to test the method a number of experiments were made[3] with pure calcium carbonate, to which certain additions were made in some experiments, to test the effect of other volatile acids. The results, shown in the following table, indicate that the method is eminently satisfactory, the only inaccurate results obtained being when a carelessly performed filtration left some $BaCO_3$ in the solution at the start of the analysis.

[1] The purifying train normally used with the absorption-tube method cannot be relied on to trap HF.

[2] Compare W. Reich-Rohrwig, Zeits. Anal. Chem., 1933, vol. 96, p. 315. (Absorption tubes used.)

[3] The experiments were carried out by Mr. S. E. Ellis of the Mineral Department.

Analyses of calcium carbonate (CO_2 43·96 %) using the new apparatus.

	Weight of $CaCO_3$ used.	Weight of $BaCO_3$ found.	Weight of $BaSO_4$ found.	Total CO_2 found.	CO_2 theory.
	grams	grams	grams	grams	grams
1 ...	0·2637	0·4892	0·0346	0·1156	0·1159
2 ...	0·2629	0·4817	0·0427	0·1201	0·1156
3 ...	0·2605	0·4740	0·0446	0·1141	0·1145
4 ...	0·2544	0·4877	0·0154	0·1116	0·1118

In no. 2 the $Ba(OH)_2$ solution was not quite clear initially.
In no. 4 1 gm. H_3BO_3 was added before the HCl.

Summary.—A simple apparatus is described for the collection of arbon dioxide in baryta solution, and the subsequent filtration and ashing of the barium carbonate produced with complete exclusion atmospheric carbon dioxide. No special apparatus is required, ne arrangement being set up from ordinary laboratory equipment; ne manipulation of the apparatus is simple and much more con-enient than the use of absorption tubes. The accuracy attainable very satisfactory. The apparatus can be adapted for micro-alysis. The effect of volatile acids other than carbonic has been sted experimentally; only hydrofluoric acid is liable to cause any terference, and a method of correcting for this, if necessary, is escribed.

On the occurrence of chondrodite in the Glenelg limestone of Inverness-shire.

By H. H. Read, D.Sc., and I. S. Double, M.Sc.
University of Liverpool.

[Read January 24, 1935.]

Introduction.—There are many old records of the occurrence of chondrodite in the British Isles. Greg and Lettsom [1] mentioned Co. Donegal in Ireland and near Loch Ness in Scotland. J. H. Collins [2] gave Wheal Druid, Redruth, and also Scotland and Ireland. The mineral is included in a list of those associated with the kyanite of Glen Urquhart, Loch Ness, Inverness-shire, given by T. Wallace.[3] Though reference to the Loch Ness locality is made by Dana in the 6th edition of the 'System' (1892, p. 540), the existence of chondrodite at Glen Urquhart, the only likely locality near Loch Ness, had been queried by M. F. Heddle so early as 1879. Heddle [4] failed to find chondrodite at this locality; he gave the name xantholite to a yellowish serpentinous substance that he suggested had been hitherto mistaken for chondrodite. In the Supplement to the 'Mineralogy of Scotland' Heddle and J. G. Goodchild [5] dismiss other Scottish localities; the supposed Glenelg chondrodite had been shown by Teall [6] to be forsterite, whilst that recorded from Rum was olivine.

It is seen, therefore, that no certain occurrence of chondrodite in Scotland, or indeed in Britain, is on record. The present note is concerned with the discovery of undoubted chondrodite in the Glenelg limestone of Inverness-shire.

The geological setting of the occurrence.—Chondrodite has been found by us in the Glenelg limestone exposed on the west side of the Allt

[1] R. P. Greg and W. G. Lettsom, Mineralogy of Great Britain and Ireland. London, 1858, p. 223.

[2] J. H. Collins, Mineralogy of Cornwall and Devon. Truro, 1871, part 2, p. 33.

[3] T. Wallace, Min. Mag., 1884, vol. 6, p. 107.

[4] M. F. Heddle, Min. Mag., 1879, vol. 3, p. 59.

[5] M. F. Heddle, Mineralogy of Scotland. Edinburgh, 1901, vol. 2, pp. 208–209.

[6] Cf. C. T. Clough and W. Pollard, Quart. Journ. Geol. Soc. London, 1899, vol. 55, p. 372.

Eas Mòr Chùil an Dùin, a tributary joining the Amhainn a' Ghlinne Shig from the south. The locality is 2 miles 16° E. of S. from the hurch at Kirkton of Glenelg, or $\frac{3}{4}$-mile NW. of the summit of Beinn Chapuill, the prominent hill, 2421 feet in height, on the south side f Gleann Beag. The exact spot can be readily located by ascending he Allt Eas Mòr Chùil an Dùin from Gleann Beag for slightly more han half a mile till the stream follows a conspicuous NW.–SE. fault-ne. The Glenelg limestone is encountered at the south-eastern end f the fault-gorge, and by following its outcrop south-south-westwards or 300 yards the chondrodite locality is reached on the peaty ridge rest of the stream. The limestone outcrop and the fault just nentioned are shown on the One-inch Geological Survey map of the rea, Sheet 71.

The geology of the Glenelg district has been described by C. T. lough.[1] A series of bands of rocks considered to be Lewisian run orth-north-east and south-south-west and are separated from one nother by bands of siliceous granulites referred to the Moine Series. he Lewisian rocks include many sedimentary types, such as lime-tones, garnet-biotite-kyanite-gneisses, biotite-schists, graphite-schists, c. With these are associated rocks of igneous or mixed parentage—clogites, garnet-amphibolites, hornblende-schists, various ultrabasic ypes, felspathic gneisses, and thinly banded, hornblendic gneisses.

The traverse up the Allt Eas Mòr Chùil an Dùin from Gleann Beag o the chondrodite locality shows thinly alternating quartzo-fels-athic and hornblendic granulitic gneisses with lenses or intercala-ions of eclogite and hornblende-garnet-rocks. The limestone of the hondrodite locality is structurally underlain by striped hornblendic ranulites and is structurally succeeded by similar rocks with thin imestone bands and eclogitic pods, as seen in the burn east of the ocality.

Petrography of the chondrodite-bearing rocks.—A synopsis of the wenty or so slices containing chondrodite cut from rocks of this ocality shows that the constituent minerals are calcite, forsterite nd forsterite-serpentine, phlogopite, chlorite, diopside, iron-ore, and hondrodite. Ferromagnesian minerals other than forsterite are not bundant, and the chondrodite-bearing rocks are essentially forsterite-narbles. They are coarse rocks formed mainly of calcite grains and ounded masses of partly serpentinized forsterite. In slices calcite

[1] C. T. Clough, The geology of Glenelg, &c., Mem. Geol. Surv. Scotland, xplan. Sheet 71, 1910, pp. 18–44.

is seen to be the dominant component in large grains; in it are set ovoid grains of colourless forsterite usually more or less converted into mesh-serpentine. The ferromagnesian mineral next in abundance to the forsterite, and one seen in every slice, is colourless phlogopite as lath-shaped sections. Often chlorite, colourless and lamellar-

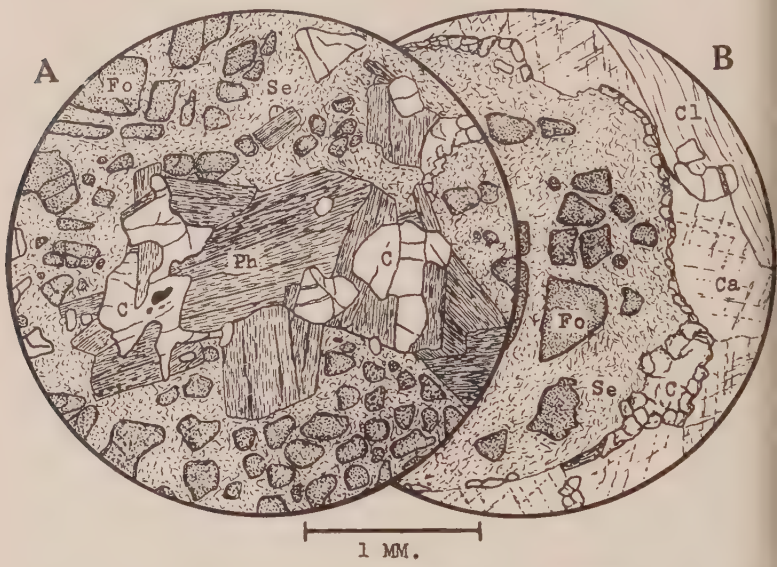

Fig. 1. Chondrodite in the Glenelg limestone. C = chondrodite, Fo = forsterite, Ph = phlogopite, Se = serpentine, Cl = chlorite, Ca = calcite, solid black = iron-ore.

twinned, accompanies the mica. Diopside is present in a few slices; it is colourless and shows excellent cleavages. The chondrodite is never abundant. In many slices it is limited to one or two minute grains, but in a few it is more abundant and the grain-size reaches 0·6 mm. In the slice richest in chondrodite some fields viewed with the 1-inch objective show over 10 % of the mineral.

The chondrodite.—The typical mode of occurrence of the mineral is as a rim of small granules around large forsterite or forsterite-serpentine masses (fig. 1 B). Rarely the rim of chondrodite extinguishes simultaneously with the forsterite. In a few cases plates of phlogopite, and still more rarely laths of chlorite or grains of diopside, are bordered by a similar rim. In addition to this usual mode of occurrence the chondrodite forms rather large spongy masses, the

terspaces of which are of calcite or chlorite, or it builds small regular grains in phlogopite, forsterite, or chlorite (fig. 1 A). Often makes irregular granular masses in calcite and then may be companied by phlogopite.

The grains are usually shapeless, but occasionally elongated forms e seen which have negative elongation and rarely a twin-plane rallel to their length. Suggestions of a cleavage are rarely und; in the best example the mineral extinguishes at nearly 30° this cleavage. Usually a few irregular cracks traverse the larger ains.

The body-colour and the pleochroism are well marked, α being ight yellow, β faint yellow or colourless, γ faint yellow or colour-ss, with absorption $\alpha > \beta = \gamma$. Twinning is fairly common; it pears to be dominantly on one law and may be either simple or mellar. No morphological directions are observable in the grains, t if the common twin-plane is taken as (001) (that most seen in ondrodite), then α : (001) exceeds 20° in the sections available. e grain, in addition to this assumed (001) twinning, shows another ich may be on (305); this suggestion is made from comparison of is twinned grain with one figured by H. von Eckermann [1] from nsjö Mountain, Sweden.

The refractive indices were determined by the immersion method, th light from a Zeiss sodium lamp. The lowest and highest values nd were α' 1·610 and γ' 1·639. The birefringence is strong.

Two thin sections showed grains suitable for the determination of e optic axial angle with the universal stage. Two grains in each ce were measured with the following results for 2V(+):

First slice	72·6° and 72·0°.
Second slice . . .	73·6° and 74·5°.

The determination of the optic axial angle in small grains by the iversal stage, even with the use of the special Leitz objective U.M. 4, not entirely satisfactory. The results given above, however, are sed on repeated observations and are sufficiently accurate to show, our opinion, that the Glenelg chondrodite has an optic axial gle between 72° and 74°.

The optical properties of the Glenelg chondrodite are similar to ose of the yellow or G-chondrodite of Mansjö Mountain, Sweden,

[1] H. von Eckermann, Geol. Fören. Förh. Stockholm, 1922, vol. 44, fig. 99, te 57.

described by von Eckermann (loc. cit., pp. 379–383). The Mansjö material has 2V 72° 14′, α 1·607, and γ 1·643. Von Eckermann remarks that the optic axial angle of the Mansjö G-chondrodite is the lowest on record.

In the Glenelg rocks the chondrodite is occasionally altered to a dense brownish, greyish, or black aggregate with the separation of iron-ore at the margins.

Other chondrodite localities in the Glenelg district.—By the kindness of Dr. H. H. Thomas, F.R.S., Petrographer to H.M. Geological Survey, we have been able to examine some of the rock-slices of the Glenelg limestone contained in the Geological Survey collection of sliced rocks. Three of these slices have been found to contain chondrodite in abundance.

The first slice, no. 12322, comes from the locality for chondrodite described in the previous pages—west side of the Allt Eas Mòr Chùil an Dùin. The slice shows many kernels of chondrodite in patches of probably micaceous material. In one patch many now-isolated fragments of an originally large crystal show excellent lamellar twinning.

The second slice, no. 12320, comes from the limestone outcrop 250 yards NNE. of Balvraid, Gleann Beag. This locality is 2 miles from that described by us, and is $2\frac{3}{4}$ miles SE. from the church at Kirkton of Glenelg. The chondrodite forms rims of markedly pleochroic granules around partly serpentinized forsterite, a mode of occurrence exactly similar to that already described by us.

The third slice, no. 7917, comes from Ross-shire, its locality being the limestone outcrop $\frac{3}{4}$ mile up from the foot of the Allt Easan Mhic Garraidh. This locality is some 4 miles NNE. from our original one, or 3 miles NE. from Glenelg church. This slice is mentioned by Clough and Pollard (loc. cit., p. 337) as showing diopside grains forming a rim around forsterite grains. This observation has been confirmed by us, but in addition we have noted that abundant yellow chondrodite occurs in the same fashion. It is interesting to recall that Pollard (loc. cit., p. 378) in the course of his separation of forsterite for analysis obtained a fraction in which a few yellow grains were observed, and that the analysis of the forsterite (loc. cit., p. 379) shows a 'trace of F'.

Conclusion.—Chondrodite thus occurs in forsterite-marbles from widely separated localities in the Glenelg district. A detailed investigation would most likely show that it is a ubiquitous component

f this limestone. In characters the Glenelg chondrodite closely esembles the yellow chondrodite from Mansjö Mountain, Sweden. ts typical mode of occurrence at Glenelg is as small granules form- ng rims around forsterite crystals; this suggests that the chondrodite as been produced from forsterite by the accession of fluorine- and ydroxyl-bearing fluids.

Apophyllite from Traprain Law, East Lothian.

By J. G. C. Anderson, M.A., B.Sc., Ph.D., Carnegie Research Scholar, and S. Elder, B.Sc., Baxter Demonstrator, University of Glasgow.

[Communicated by Dr. W. Q. Kennedy; read January 24, 1935.]

Introduction and mode of occurrence.—During a visit in 1929 to the well-known phonolitic laccolith of Traprain Law, East Lothian, beautiful crystals of apophyllite were discovered in drusy cavities. It was found possible to collect numerous specimens which are now in the Hunterian Museum, University of Glasgow (M 5970). There is no previous record from the locality and the following is a brief description of the rock and its associates.

Along with the apophyllite occur well-formed icositetrahedra of analcime.[1] A thin section reveals that the apophyllite is of later crystallization than the analcime. The latter mineral lines the walls of the cavities, with which the apophyllite is seldom in contact. Radiating fibres of pectolite are occasionally seen on the surface of the analcime. The discovery of the pectolite is due to Mr. D. M. Cookson of Cambridge University. Mr. Cookson, to whom the present authors were referred by Mr. D. Balsillie, very kindly forwarded specimens.

The phonolite bordering the druse is considerably decomposed. The first episode in the infilling of the cavity, preceding the formation of the analcime and the apophyllite, was a crystallization of albite and aegirine-augite. These minerals, though somewhat altered, are fresher than the felspar (soda-orthoclase) and pyroxene (aegirine-augite) in the body of the rock. Chloritic aggregates are found included in, or on the surface of, the apophyllite crystals.

Physical and optical properties.—The faces represented are *c* (001), *a* (100), and *p* (111); *c* is the best developed, giving the crystals a tabular form. The edge *ac* is commonly 0·75 cm. in length but may

[1] Analcime as a primary constituent of the phonolite has been recorded by E. B. Bailey, The geology of East Lothian, Mem. Geol. Surv. Scotland, 1910, p. 129; and by A. G. MacGregor and F. R. Ennos, The Traprain Law phonolite. Geol. Mag., 1922, vol. 59, pp. 517–519.

twice this amount. The basal cleavage is perfect, and there is an nperfect prismatic cleavage distinct enough to determine the edges crystal fragments. The colour varies from pale pink to colourless, e basal face exhibiting the characteristic pearly lustre. The refrac- ve index is slightly above 1·53, while the specific gravity is 2·38. he birefringence is low. The majority of the crystals are uniaxial, ut occasional pseudo-biaxial figures occur; in all cases a positive gn was recorded. In basal section the rings of the interference- gure are only white and black, no matter how thick the section. other sections the well-known abnormal interference-colours were bserved.

Other Scottish localities.—A comprehensive list of Scottish localities r apophyllite is given by Heddle.[1] The majority of these are in e Tertiary basalt lavas of Skye. Of special interest in the present nnexion are occurrences at Talisker, where the mineral is associated th pectolite (and scolecite), and at Rudha nan Clach, Loch Braca- le, where cavities neighbouring those with apophyllite contain mong other minerals) analcime. In Mull, at the south end of the ilderness, north of Loch Scridain, apophyllite occurs on analcime nd is penetrated by scolecite). Association of apophyllite and ctolite is also seen in quartz-dolerite sills in Auchinstarry quarry, lsyth, Stirlingshire, and in Ratho quarry, Midlothian. An additional currence to those given by Heddle is in the analcime-syenite of the wford Bridge sill, Ayrshire.[2]

M. F. Heddle, Mineralogy of Scotland. Edinburgh, 1901, vol. 2, pp. 81–82.

G. W. Tyrrell, Some dolerite-sills containing analcite-syenite in central rshire. Quart. Journ. Geol. Soc. London, 1928, vol. 84. The apophyllite is not ntioned by the author, but is referred to in the discussion by Dr. H. H. mas (p. 568).

The rôle of kyanite in the 'hornfels zone' of the Carn Chuinneag granite (Ross-shire).

By C. E. Tilley, Ph.D., B.Sc.
Professor of Mineralogy and Petrology, University of Cambridge.

[Read March 14, 1935.]

THE metamorphism surrounding the granite of Carn Chuinneag in eastern Ross-shire [1] provides the classical example of polymetamorphism in which a regional metamorphism is superimposed on a normal thermal metamorphism.

Prior to the regional alteration a pelitic facies of the Moine sediments suffered metamorphism of a purely thermal type in the vicinity of the granite. At a subsequent date the whole region was involved in fold movements with the production of crystalline schists. In this deformation the belt of rocks surrounding the granite yielded in such a way that belts of the hornfels zone moved *en masse* and are preserved amidst rocks which are now typical crystalline schists, and all stages of transition between genuine hornfelses and typical mica schists can be traced in the field.

The hornfels zone is particularly well preserved in the vicinity of Kildermorie Lodge and south-east of Glencalvie Lodge. The character of these hornfelses has been described in detail in the Survey Memoir. Though highly metamorphosed they show the original lamination and consist of alternating bands of siliceous and argillaceous composition. One of the most striking mineralogical features of the pelitic members is the presence of abundant garnet. Where they are least affected by the second metamorphism the hornfelses are constituted of quartz, orthoclase (variable), biotite, muscovite (variable) and garnet, to which may be added acid plagioclase (oligoclase and albite), iron-ores, and graphite.

The widespread occurrence of garnet in the hornfels zone merited further inquiry into its nature. The garnet from a typical hornfels was therefore isolated and a determination of ferrous and manganous oxide made. The results, FeO 32·40 %, MnO 0·72 % (almandine 74·7

[1] Mem. Geol. Surv. Scotland, 1912, Explanation of sheet 93.

essartine 1·7), make clear that the mineral is essentially an alman-
ne. The occurrence therefore belongs to the rare type in which a
ermal aureole carries an almandine- rather than a spessartine-rich
pe of garnet.

Amongst the thermal products recorded by the Survey officers none
more striking than the chiastolite of the hornfelses of Carn Loch
n Amhaichean. In these horn-
ses outlines of original chiastolite
ystals occur, but all chiastolite
bstance has disappeared, the core
the pseudomorphs being filled
th divergent fibres of kyanite,
ilst the periphery is occupied by
icite (fig. 1).

Fig. 1. Kyanite fibres surrounded by sericite forming a pseudomorph after chiastolite. ×120 diameters.

It seems clear that chiastolite has
en a not infrequent constituent of
e hornfelses, but is represented
w only by the pseudomorphs
t referred to, or by ovoid areas
sericite where the rocks have suffered visible deformation.

A suite of rocks collected from the hornfels zone north of Kilder-
rie Lodge has revealed a further more extensive development of
anite in these hornfelses. From an examination of a series of
ks within the zone kyanite can now be recorded in the following
ociations:

1. Replacing chiastolite crystals.
2. Replacing cordierite, being then accompanied by biotite.
3. As swarms of fine needles associated with biotite in the more
illaceous bands.
4. As a constituent in coarser-grained crystals of quartz-kyanite
nules cutting the banding of the hornfelses.
5. In quartzose areas immediately adjacent to garnet porphyro-
sts.

The first method of development has been discussed in detail in
Survey Memoir. No original cordierite has been with certainty
ognized in the aureole, but pseudomorphs have been recognized.
seems probable, however, from the petrographical character of the
reole rocks—the abundance of chiastolite—that it was once an
portant constituent. The typical xenoblastic character and sieve
ture of hornfels cordierite render its recognition—when replaced

by other minerals—less certain than is the case with idioblasti chiastolite pseudomorphs.

Nevertheless, as remarked above, its former presence is revealed in pseudomorphs in rocks preserving a typical hornfels texture These pseudomorphs are now composed of bundles of fine needles o kyanite set in a base of muscovite and biotite. The original cordi

Fig. 2. Biotite-hornfels, Carn Chuinneag, showing biotite, quartz, acid plagioclase, and pseudomorphs of kyanite, biotite, and muscovite after cordierite. Kyanite is abundant in the pseudomorphs and forms fibres fringing the felspar grains. ×100 diameters.

erite crystals were subidioblastic and were associated with quart alkali-felspar, and biotite (fig. 2). The needles of kyanite do n exceed 0·05 mm. in length and are identified by isolation after trea ing the rock powder with cold hydrofluoric acid.

In addition to this manner of occurrence kyanite occurs as swarn of fine needles in bands associated with biotite and muscovite. The are thus specially confined to the argillaceous laminae of the origin sediment. In some cases little remains to suggest how these kyani swarms have arisen, but in others the arrangement is suggestive replacement of xenoblastic cordierite.

A most striking case of the occurrence of kyanite in these rocks the development of larger crystals of kyanite ($\frac{1}{2}$ mm. in length) ass

ed with quartz—in some cases biotite—in venules which typically across the banding of the hornfelses (fig. 3). These quartz-kyanite ns are characteristic of the hornfelses which contain kyanite also he groundmass of the rock in the form of fine needles. Crystals yanite of comparable size are elsewhere found only in the imme-

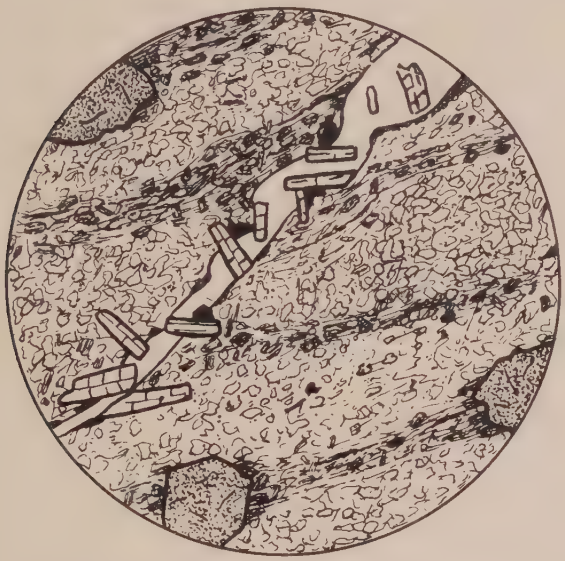

Fig. 3. Quartz-kyanite vein crossing the banding of a garnetiferous hornfels. Kyanite is also developed as fine needles associated with biotite in the argillaceous laminae which alternate with siliceous bands. ×30 diameters.

te vicinity of garnet porphyroblasts, more particularly those which sess a quartzose environment.

ll the rocks bearing kyanite in the associations already described ong to the hornfels zone proper. Texturally they preserve the ight bedding of the original sediment whence they were derived. he transformations incident on the second metamorphism have n described in detail in the Survey Memoir, but it will be con-ient to make reference to some of these changes in discussing the blem of the kyanite development. The production of abundant te mica at the expense of alkali-felspar, the development of a stose texture with orientated mica plates, and a fine-scale folding he laminae often with a resultant loss of the banding so prominent

in the hornfels zone are the successive changes the hornfelses experience in their transition to mica-schists. Typical crystalline schists made up of quartz, muscovite, biotite, and garnet are thus produced. At an early stage in this conversion all traces of kyanite disappear, the mineral being presumably used up in the manufacture of muscovite. Kyanite is not recorded in the schists outside the hornfels zone.

Kyanite is found in the hornfels zone in rocks in which a minimum amount of sericitization has taken place, but it is also characteristic of those rocks in which muscovite development is considerable. In all cases the banding—where present originally—is well preserved. None of the rocks examined contain sillimanite, the fine needles appearing like sillimanite proving on isolation with hydrofluoric acid to be kyanite.

The manner of development of kyanite in the hornfelses having now been presented, the important problem of the genesis of this mineral remains for consideration. The principal points of interest lie (1) in the development of kyanite in rocks still preserving much of their original character as hornfelses, (2) the disappearance of kyanite when the hornfelses pass out into the schistose zone.

That kyanite cannot be considered a primary mineral of the hornfelses is, I think, clearly evident from its occurrence replacing chiastolite and cordierite. On the other hand, the imposition of regional metamorphism sufficient to induce noteworthy textural changes in the hornfelses leads to its disappearance. Outside the aureole the Moine sediments made over into crystalline schists do not appear to have reached the kyanite grade of metamorphism. Kyanite, in other words, has only a temporary status in the regional metamorphism.

The available evidence appears to warrant the belief that kyanite has arisen under the imposition of stress, in the first place under conditions which have been unaccompanied by visible deformation of the rock, for the textures of the hornfelses are frequently preserved but the kyanite persists through the initial stages in the development of orientated flakes of sericite—one of the first signs of visible textural change. The development of the kyanite-biotite swarms is also in some cases one of a directional kind with a definite orientation oblique to the banding—indicative of crystallization under the imposition of stress.

The quartz-kyanite veins cutting the banding of the hornfelses represent a special case of metamorphic differentiation; probably

uartz and kyanite represent material segregated from the ground-
nass of the rock. That migration of kyanite substance in addition
o silica is involved seems to be demanded by the occurrence of
yanite in the veins opposite siliceous bands and not confined to the
roximity of argillaceous layers where fine needles of kyanite are
ommonly present. The kyanites have, however, no constant orienta-
ion in the veins.

Can the kyanite be considered as developed under the incidence of
tress while the aureole was still hot? If this were so the zone of
neared hornfelses developed between the granite and the hornfels
one might be expected to carry kyanite, but these rocks are trans-
ormed into crystalline schists without kyanite resembling those
utside the aureole.

I believe the most reasonable explanation is to be found in the
ineralogical constitution of the rocks upon which dynamic meta-
orphism was imposed. The kyanite production depended upon the
rior presence of andalusite and cordierite, and kyanite itself repre-
nts but a temporary intermediate stage in the production of
rystalline schists free from kyanite.

Kyanite remains one of the few minerals which still merit descrip-
on as 'stress minerals'. Without denying the possibility that
anite might be generated without the incidence of stress, yet it is
be noted that the development of this mineral at a definite stage
regions of progressive regional metamorphism appears to demand
t only the appropriate conditions of temperature but also of
earing stress. If this were not so it is strange that kyanite has
ver been recorded as a product of simple thermal metamorphism.

As regards the occurrence of quartz-kyanite veins, which have
metimes been used in argument against the concept of kyanite as
stress mineral, it is to be remembered that in these cases the veins
cur in typical stress rocks—crystalline schists which usually carry
anite in the groundmass from which, no doubt, the kyanite of the
ins is segregated. In the case already discussed, though the quartz-
anite veins occur in 'hornfelses' these rocks themselves give
ar evidence of the incidence of stress.

The occurrence of kyanite at Carn Chuinneag is thus not in conflict
th the prevalent concept of this mineral as a stress mineral, though
presents the unusual feature of kyanite arising as a transient
ineral phase in the manufacture of crystalline schists.

MINERALOGICAL ABSTRACTS

(Vol. 6, No. 2, June, 1935.)

Notices of Books.

NGLISH (George Letchworth). *Getting acquainted with minerals.* Rochester, New York (Mineralogical Publishing Company), 1934, xi + 324 pp., 1 pl., 257 text-figs. Price $2·50.

This book is written in an easy conversational style with the ject of spreading enthusiasm for the collecting of minerals. There e several good chapters 'about minerals in general' followed by escriptions of minerals'. In the latter part minerals are grouped der the predominant element they contain, arranged alphabetically m aluminum [= aluminium] to zirconium, with a separate section rock-forming minerals. A short section deals with rocks. Appen- es give tables for the determination ot minerals by colour and rdness, and a pronouncing vocabulary of mineral names. The ok is attractively illustrated with good line drawings of crystals d photographic reproductions of specimens. The author has an exceptionally wide experience in collecting and distributing neral specimens, but none of his interesting reminiscences are orded in the book. L. J. S.

HIBBER (H. L.). *The geology of Burma.* With contributions by R. RAMAMIRTHAM, and a foreword by L. Dudley STAMP. London (Macmillan & Co.), 1934, xxvi + 538 pp., 26 pls., 37 text-figs. Price 30*s.*

— *The mineral resources of Burma.* London (Macmillan & Co.), 1934, xv + 320 pp., 10 pls., 13 text-figs. Price 18*s.*

These companion volumes give a full and detailed account of the logy and mineral resources of Burma, in both of which sections re is considerable diversity. The author was formerly Professor Geology in the University of Rangoon and is now on the staff of Geological Survey of India. He has worked extensively in the d and the volumes contain many original observations and much v information. The physical features of the country are varied l the historical geology shows an almost complete sequence from thaean to Pliocene. Igneous rocks are dealt with fully (pp. 286–

507) with detailed petrographical descriptions and many chemical analyses. The volume on the mineral resources also covers a wide range, giving interesting chapters on gemstones (ruby, &c.), jadeite, amber, ores of iron, lead, silver, zinc, tin, wolfram, &c., with full particulars about each of the mines. The two handsome volumes are well printed on good paper and are admirably illustrated; they will long remain the standard work on the subject. L. J. S.

Stočes (Bohuslav) & White (Charles Henry). *Structural geology with special reference to economic deposits.* London (Macmillan & Co.), 1935, xv + 460 pp., 1 pl., 666 text-figs. Price 25*s*.

This is a nice picture-book with more pictures than pages. Two of the figures are described as 'plates', while many others, also occupying a whole page, are numbered as text-figures. Many excellent diagrams, sections, and sketch-maps of geological structures and attractive views of scenery (largely from Bohemia and Great Britain) are given; and a very good idea of the subject can be gained by looking through these and reading the clear descriptions beneath each. This is easier than reading the text, which is much broken up by the numerous figures: several pages may have to be turned over before finding a couple of lines of text. The book is an elaboration of one already published in Czech and German by the first author, who is Professor of Geology in the National School of Mines in Czechoslovakia. L. J. S.

Fox (Cyril S.). *A comprehensive treatise on engineering geology.* London (The Technical Press), 1935, xv + 392 pp., 31 pls., 2 folding tables, 70 text-figs. Price 35*s*.

This is an elaboration of the author's previous book 'Civil engineering geology' (London, 1923). The introductory and theoretical portions include much text-book matter that can be of no immediate use or interest to the practical civil engineer. Part I, Building materials, concludes with a useful chapter on the choice of materials. Part II, Field operations, deals more practically with stability of hill-sides and cliffs, quarrying and tunnelling, retaining and protecting walls, and building sites. Part III deals with water supply. The author is on the staff of the Geological Survey of India, and many of the examples and illustrations are taken from that country. A rather hasty compilation is suggested and there are several misprints. L. J. S.

New Minerals.

OUNTAIN (Edgar D.). *Two new bismuth minerals from South Africa.* Min. Mag., 1935, vol. 24, pp. 59–64.

Bismoclite (BiOCl); bokspute ($6PbO.Bi_2O_3.3CO_2$).

HUBNIKOVA (O. M.) & YUFEROV (D. V.)] Шубникова (О. М.) и Юферов (Д. В.). Справочник по новым минералам 1922–1932 гг. [*Report on new minerals, years 1922–1932.*] Edited and with preface by A. E. FERSMAN, Leningrad, 1934, 167 pp., 34 figs. Price 2*r.* 25*k.*

Full details with references to the literature (including Min. Abstr.) e given of all the 360 new minerals described during the period 22–32. The minerals are arranged according to Dana's system classification, and alphabetical indexes of names in Russian and glish are added. Dana's 'Textbook of mineralogy', third edition, 22, is taken as the starting-off point [a fourth edition of which peared in 1932; M.A. **5**–193]. L. J. S.

VYAGINTZEV (O. E.)] Звягинцев (О. Е.). Новый минерал, содержащий металлы платиновой группы. ZVĬAGINCEV (SWJAGINZEW) (O.). *Ein neues, Metalle der Platingruppe enthaltendes, Mineral.* Доклады Акад. Наук СССР (Compt. Rend. Acad. Sci. URSS), 1934, vol. 4, pp. 176–178 (Russ.), 178–179 (Germ.).

Residues of Uralian platinum insoluble in aqua regia include grains iridosmine and of the new mineral. Those of the latter are silver-ite, irregular in form, and 0·5–2 mm. across; they are brittle and eak with an irregular fracture; H. > 7, sp. gr. 20. Analysis gave 51·7, Os 25·5, Ru 3·5, Au 19·3, Fe trace. X-ray examination ows a face-centred cubic structure with *a* 3·816 Å. (similar to that iridium for which *a* is 3·822 Å.). The mineral is a solid solution of d and osmium in cubic iridium, and is named *aurosmirid*; whereas dosmine is a solid solution of iridium, &c., in hexagonal osmium .A. **5**–173, 174]. L. J. S.

INOFF (G.). *Note on a new mineral from Långban (sahlinite).* With chemical analysis by R. BLIX. Geol. För. Förh. Stockholm, 1934, vol. 56, pp. 493–494.

The pale sulphur-yellow scales, occurring in dolomite with haus-nnite, are monoclinic with perfect (010) cleavage, $Bx_a \perp (010)$, 96° 38′, $n > 1·74$, sp. gr. 7·95, H. 2–3. Analysis gave PbO 89·33,

As_2O_5 6·57, CaO 0·46, CO_2 0·43, Cl 4·05, H_2O 0·10 = 100·94, representing an extremely basic chloro-arsenate, $12PbO.As_2O_5.2PbCl_2$.

L. J. S.

De Leenheer (L.). *Over mindigiet, een nieuw kobalthydroxyde.* Natuurwetenschappelijk Tijdschrift, Gent, 1934, vol. 16, pp. 237–241, 2 figs.

Mindigite occurs with stainierite [M.A. **4**–248, 347] at Mindigi, 58 km. WSW. of Kambove in Katanga. It forms a pitch-black crust with shining surface on haematite. Fracture conchoidal, streak brownish-black, H. $2\frac{1}{2}$, sp. gr. 3·07. Polished sections and X-ray examination show the material to be colloidal. Two analyses gave Co_2O_3 76·05 (77·05), CuO 9·22 (7·34), H_2O 14·79 (14·74), insol. —(0·66), total 100·06 (99·79), corresponding with $9Co_2O_3.2CuO.16H_2O$ or $2(Co_2O_3,CuO).3H_2O$. Most of the water is lost gradually up to 430° C. and at higher temperatures there is a loss of oxygen with formation of Co_3O_4 and CoO; at 1100° C. fuses to a dark-blue mass. The mineral is thought to be distinct from the heterogenite (now called lubumbashite) previously described from Katanga [M.A. **1**–243].

L. J. S.

Grill (E.). *Su un fosfato di ferro e di manganese delle pegmatiti di Olgiasca.* Periodico Min. Roma, 1935, vol. 6, pp. 19–23.

Bluish-black nodules in pegmatite from Olgiasca, Lake Como, are salmon-pink on a fresh fracture, darkening to brown on exposure to the air. H. $4\frac{1}{2}$–5, sp. gr. 3·72–3·76, α' 1·708, β' 1·713, γ' 1·724, 2V 68°, positive. Analysis, P_2O_5 38·94, FeO 32·33, MnO 23·32, CaO 4·50, H_2O (+110°) 0·39, H_2O (−110°) 0·15 = 99·63, agrees with $R''_3P_2O_8$. The mineral is named *repossite* and is suppose to differ from graftonite (S. L. Penfield, 1930).

L. J. S.

Walker (T. L.). *Enelectrite, a new mineral found in chemawinite.* Univ. Toronto Studies, Geol. Ser., 1934, no. 36, pp. 11–12, 1 fig.

Minute (10–250 μ) colourless crystals are occasionally found embedded in amber (chemawinite) from Chemahawin on Cedar Lake, Manitoba. They are monoclinic and lath-shaped, flattened on (100) with elongation along the *c*-axis and a cross cleavage. Optic axial plane $\perp$ (010), $\beta : c = 20°$, $a = b$, 2V large, positive, α 1·535, β 1·538. The mineral is presumably a hydrocarbon formed from the resin at the time of its solidification.

L. J. S.

OSHAG (William F.). *Burkeite, a new mineral species from Searles Lake, California.* Amer. Min., 1935, vol. 20, pp. 50–56, 3 figs.

The salt $2Na_2SO_4.Na_2CO_3$ obtained artificially from the brine of Searles Lake was called burkeite by J. E. Teeple in 1921 [Min. Mag. 1–559; M.A. **3**–162]. It has now been found of natural occurrence in a bore-hole at a depth of 115–125 feet, associated with halite, trona, gaylussite, &c. The small white orthorhombic crystals are cushion-shaped or x-shaped twins, with prism-angle 59° 42′. Hardness $3\frac{1}{2}$, sp. gr. 2·57. Optic axial plane (100), $a = c$, negative, $2V$ 34°, α 1·448, β 1·489, γ 1·493. Analysis gave SO_3 39·96, CO_2 11·72, Cl 0·09, Na_2O 47·89, K_2O nil, H_2O 0·04, insol. 0·04 = 99·74. The relation of burkeite to other salt minerals and their crystallization from the brines are discussed. It is suggested that the crystals described as $2Na_2SO_4.Na_2CO_3$ by A. F. Rogers [M.A. **3**–162] were glauberite. L. J. S.

OSHIMURA (Toyofumi). "*Todorokite*," *a new manganese mineral from the Todoroki mine, Hokkaido, Japan.* Journ. Fac. Sci. Hokkaido Univ. Sapporo, Ser. 4, 1934, vol. 2, pp. 289–297, 2 pls.

A soft black manganese ore with lamellar structure and reniform surface occurs in auriferous quartz veins in Tertiary volcanic rocks. It consists of a loose spongy aggregate of minute fibrous flakes, resembling graphite, but brown and pleochroic by transmitted light. These appear to be monoclinic with perfect (100) and (010) cleavages and optic axial plane (010). Sp. gr. 3·67. Analysis, MnO 65·89, H_2O 12·07, $H_2O(+)$ 9·72, $H_2O(-)$ 1·56, SiO_2 0·45, TiO_2 trace, CO_2 trace, P_2O_5 0·42, SO_3 0·28, Al_2O_3 0·28, Fe_2O_3 0·20, MgO 1·01, CaO 3·28, BaO 2·05, Na_2O 0·21, K_2O 0·54, insol. 1·28 = 99·24; $2(RO.MnO_2.H_2O).3(Mn_2O_3.3MnO_2.2H_2O)$. This formula is compared with that of nontronite [M.A. **3**–451], and a relation is traced between the physical characters of the two minerals. The new mineral is an alteration product of inesite (α 1·624, β 1·643, γ 1·651) and is associated with rhodochrosite and opal. A classification is given of the several minerals of the manganomelane group. L. J. S.

APLES (Lloyd W.). *Austinite, a new arsenate mineral, from Gold Hill, Utah.* Amer. Min., 1935, vol. 20, pp. 112–119, 3 figs.; pp. 199–200.

This occurs with quartz, limonite, and adamite as small colourless sphenoidal orthorhombic crystals with the forms $m(100)$, $p(111)$ or

$\rho(1\bar{1}1)$, and sometimes $b(010)$ and $q(011)$; $a:b:c = 0{\cdot}657:1:0{\cdot}832$. The crystals have a bladed or acicular habit with sceptre-like terminations. Etch-figures distinguish right- and left-handed crystals. Cleavage (110), sp. gr. 4·12. Optic axial plane (100), $Bx_a = b$, positive, 2V 47°, α 1·759, β 1·763, γ 1·783. Analysis by R. B. Ellestad gave As_2O_5 42·7, P_2O_5 0·1, CaO 19·2, ZnO 32·5, H_2O 3·6, insol. 2·4 = 100·5, corresponding with $2CaO.2ZnO.As_2O_5.2H_2O$ or $CaZn(OH)AsO_4$. [Cf. brickerite, M.A. **5**–200.] L. J. S.

Palache (Charles). *Lindgrenite, a new mineral.* Amer. Min., 1935, vol. 20, p. 187 (abstract).

This occurs as green crystals in veinlets of limonitic quartz in the copper mine at Chuqicamata, Chile. The crystals are monoclinic with $a:b:c = 0{\cdot}5941:1:0{\cdot}5124$, $\beta = 77°\ 48'$, and dominant forms (010), (100), (121), $(\bar{1}31)$, they are tabular on (010), which is also a direction of perfect cleavage. The composition is $Cu_2MoO_4.Cu(OH)_2$. L. J. S.

Artificial Minerals.

Noll (W.). *Hydrothermale Synthese des Kaolins.* Min. Petr. Mitt. (Tschermak), 1934, vol. 45, pp. 175–190, 2 figs.

—— *Zur genetische Deutung der hydrothermalen Kaolinsynthese.* Centr. Min., Abt. A, 1934, pp. 80–84.

A full account is now given [M.A. **5**–255]. L. J. S.

Grigoriev (D. P.). *Künstliche Darstellung der Magnesiumglimmer.* Centr. Min., Abt. A, 1934, 219–223, 3 figs.

Magnesia-mica was prepared by fusing a mixture of MgO, K_2CO_3, Al_2O_3, SiO_2 with CaF_2 in a graphite crucible. The product shows scales of mica 8–9 mm. across with spinel in a glassy matrix. On the walls of cavities six-sided crystals are developed. Analysis of the scales gave SiO_2 43·46, Al_2O_3 21·90, MgO 19·98, CaO 6·43, K_2O 5·99, F 2·59 = 100·35; sp. gr. 2·746, α 1·520, γ 1·558, 2E 0°, negative. L. J. S.

Dwyer (F. P.) & Mellor (D. P.). *X-ray diffraction studies of the crystallisation of amorphous silica.* Journ. Roy. Soc. New South Wales, 1934, vol. 67 (for 1933), pp. 420–428. [Cf. M.A. **5**–382.]

Silica gel or opal when heated with KCl for 30 hours at 810° C. yielded β-cristobalite, while vitreous silica gave a mixture of α- and β-cristobalite. With Na_2WO_4 or NaCl as a flux α-tridymite resulted. L. J. S.

ENOGLIO (Massimo). *Nuove ricerche sulla zaratite: zaratite sintetica.* Periodico Min. Roma, 1934, vol. 5, pp. 265–274, 1 pl. [Cf. M.A. **5**–472.]

Grass-green granular zaratite was prepared by the slow action at rdinary temperature of a solution of $NiCl_2$ on nesquehonite ($MgCO_3$. H_2O). It is optically isotropic with n 1·58–1·60, sp. gr. 2·664, and ves the same X-ray pattern as zaratite from Texas, Pennsylvania. nalysis, NiO 59·30, CO_2 11·42, H_2O 29·08, agrees with the formula $iCO_3.2Ni(OH)_2.4H_2O$. The weak birefringence sometimes shown by ratite is attributed to mechanical deformation of fine fibres.

L. J. S.

ROWNMILLER (L. T.). *A study of the system lime-potash-alumina.* Amer. Journ. Sci., 1935, ser. 5, vol. 29, pp. 260–277, 3 figs.

A portion of the system CaO–K_2O–Al_2O_3 is worked out in detail y thermal and optical methods. The compound $K_2O.Al_2O_3$ is cubic ith n 1·603. Corundum and β-Al_2O_3 crystallize from Al_2O_3 with 5 %, K_2O at 1550° C. L. J. S.

RANKE (Walter), MEISEL (Karl), & JUZA (Robert). *Über die Verwandtschaft von Phosphor zu Eisen.* Zeits. Anorg. Chem., 1934, vol. 218, pp. 346–359, 3 figs.

EISEL (Karl). *Über die Kristallstruktur des FeP_2.* Ibid., pp. 360–364, 1 fig.

The compounds Fe_3P, Fe_2P, FeP, and FeP_2 are confirmed by X-ray d vapour-pressure measurements. FeP_2 is orthorhombic and of the arcasite type; the unit cell, a 2·72, b 4·97, c 5·66 A., contains $2FeP_2$; 5·07. L. J. S.

UERTLER (W.) & LANDAU (G.). *Kristallisationsdiagramme des Systems Kupfer-Blei-Schwefel.* Zeits. Anorg. Chem., 1934, vol. 218, pp. 321–345, 16 figs.

Equilibrium diagrams of the systems Pb–Cu_2S–PbS and Pb–Cu_2S– from thermal data. L. J. S.

OUGLAS (C. B. E.). *Native wire silver: notes on its formation and possible significance.* Trans. Inst. Mining & Metall. London, 1933, vol. 42 (for 1932–33), pp. 398–402, 2 pls.

Buttons of silver sulphide heated at 135° C. showed a minute owth of wire silver on the surface. This proves that wire silver nature is not necessarily deposited from solution. L. J. S.

Forestier (Hubert) & Guiot-Guillain (Georges). *Une nouvelle variété ferromagnétique de sesquioxyde de fer.* Compt. Rend. Acad. Sci. Paris, 1934, vol. 199, pp. 720–723, 1 fig.

This is obtained from $Fe_2O_3.4BeO$ (prepared by adding in the required proportions the two nitrates or chlorides to NH_3,aq.) by dissolving out the BeO with dilute HCl. The most strongly magnetic product (much more so than any other form of Fe_2O_3, with Curie point at 220°) is obtained by heating $Fe_2O_3.4BeO$ for 6 minutes at 720° C., which apparently decomposes it into Fe_2O_3 and BeO. More prolonged heating converts it to ordinary Fe_2O_3. X-ray examination shows the new variety to be a slightly deformed rhombohedral form of Fe_2O_3. [Cf. Goldsztaub, M.A. **5**–179.] C. A. S.

Chassevent (Louis). *Sur la formation de composés définis cristallisés au début du durcissement des ciments silicieux.* Compt. Rend. Acad. Sci. Paris, 1934, vol. 199, pp. 673–675.

X-ray examination of the precipitates obtained on mixing one volume of solution of SiO_2 (0·84–6·4 g. per litre) with two of one of CaO (0·080–1·06 g. per litre) and agitating out of contact with the air, after intervals varying from 2 hours to 7 days showed the invariable presence of one and only one crystalline compound, the hydrated monosilicate, $CaO.SiO_2.2{\cdot}5H_2O$. [Cf. Le Chatelier, 1884.] C. A. S.

Kamenezki (S. A.). *Die Wirkung von verdünnten Silberlösungen auf mineralische Sulfide.* Zeits. Anorg. Chem., 1934, vol. 219, pp. 335–340, 5 figs.

The action of dilute $AgNO_3$ on chalcopyrite, pyrite, galena, covelline, chalcosine, orpiment, and blende has been studied. The velocity of the reaction (which produces silver sulphide and the nitrate of the metal) increases with the solubility of the sulphide. Side reactions are discussed. M. H. H.

Benrath (A.) & Blankenstein (A.). *Über Mischkristalle in der Vitriolreihe. I–II.* Zeits. Anorg. Chem., 1933, vol. 216, pp. 41–48, 6 figs; 1934, vol. 217, pp. 170–174, 4 figs.

Benrath (A.) & Thiemann (W.). *Über Mischkristalle in der Vitriolreihe. III–IV.* Ibid., 1934, vol. 217, pp. 347–352, 3 figs.; 1935, vol. 221, pp. 423–426, 1 fig.

The systems $MnSO_4$–$MgSO_4$–H_2O, $MnSO_4$–$ZnSO_4$–H_2O, $NiSO_4$–$CoSO_4$–H_2O, and $CdSO_4$–$MnSO_4$–H_2O have been studied in detail at

rious temperatures. [Cf. Ilesite, fauserite, &c. Cf. Min. Mag., 31, vol. 22, p. 510, and M.A. **5**–258.] M. H. H.

RNOWA (Nina). *Schmelzdiagramm des Systems ZrO_2–SiO_2.* Zeits. Anorg. Chem., 1934, vol. 218, pp. 193–200, 2 figs.

Zircon, m.p. 2430° C., is the only compound formed from fusion the system ZrO_2–SiO_2. ZrO_2 can take up approximately 10 % O_2 in solid solution. The liquidus has been fully worked out.

M. H. H.

UTZELNIGG (Artur). *Weiteres über das zeigelrote Zinkoxyd. Zugleich eine Erwiderung an H. Berg.* Zeits. Anorg. Chem., 1934, vol. 221, pp. 46–48.

Further notes on the red zinc oxide, which is regarded as different om that of Mylius and Fromm. A sulphur-yellow product is also escribed. [Cf. M.A. **5**–257.] M. H. H.

LMONI (Renato). *Gli idrati dell'alluminato bicalcico.* Gazz. Chim. Ital., 1934, vol. 64, pp. 719–734.

The compound $2CaO.Al_2O_3$ forms hydrates with 1, 3, 5, 6, 7, $7\frac{1}{2}$, 9, 10, and 11 mol. H_2O. Debyeograms show that all the hydrates ith 5 or more mols. H_2O have practically the same structure. e mono- and trihydrates also give practically identical Debyeo-ams. [This series are probably not individual hydrates; there is obably a zeolitic hydrate with 11–5H_2O and another with 3–1H_2O.] hese compounds are compared with other calcium aluminates and eir constitution discussed. [Cf. M.A. **5**–448–450.] M. H. H.

REDIG (M. A.), FRANCK (H. H.), & FÜLDNER (H.). *Beiträge zur Kenntnis der Kalk-Phosphorsäure-Verbindungen II.* Zeits. Elektrochem., 1933, vol. 39, pp. 959–969, 3 figs. [Cf. M.A. **5**–318.]

The conclusions of G. Trömel [M.A. **5**–318] and of A. Schleede, . Schmidt, and H. Kindt [M.A. **5**–321], that a pure oxyapatite oelckerite] cannot be obtained, and that the production of an patite-like compound in the system CaO–P_2O_5 is dependent on the esence of H_2O (leading to hydroxyapatite) are confirmed. But hile pure oxyapatite cannot exist, preparations containing as much 60–70 % of it in isomorphous mixture with hydroxyapatite or uorapatite can be obtained. No differences in the Debyeograms these products and of pure hydroxyapatite or fluorapatite could e observed. Precipitated calcium phosphate is probably always

hydroxyapatite. A number of carbonate-bearing apatites (staffelite from the Eifel, phosphate rock, an ox tooth) showed small distinct differences in their Debyeograms from hydroxyapatite or fluor-apatite; this is evidence of the existence of a true carbonate-apatite. A different interpretation is given of some of the Debyeograms obtained by S. B. Hendricks and others [M.A. **5**–184]. Artificial carbonate-hydroxyapatite was obtained by a wet method. Other artificial apatites contained calcium cyanamide, alumina, or ferric oxide. Sulphate-apatite could not be prepared, but a product was obtained which may be a sulphide-apatite. The $\alpha \rightleftharpoons \beta$ enantiotropic change of $Ca_3(PO_4)_2$ is markedly sensitive to the presence of water or CaO. M. H. H.

Gaubert (P.). *Hémihydrate de sulfate de calcium obtenu par voie humide et polymorphisme du sulfate anhydre.* Bull. Soc. Franç. Min., 1934, vol. 57, pp. 252–267, 1 pl., 6 text-figs.

Researches previously published [M.A. **5**–451] are described in more detail. The conclusion of P. Gallitelli [M.A. **5**–452] that $CaSO_4.\frac{1}{2}H_2O$ is monoclinic is rejected, and it is regarded as rhombohedral [but Gallitelli's definitely monoclinic Lauegram is not explained]. After partial dehydration the crystals are not homogeneous. The water content is not zeolitic. M. H. H.

Caspari (W. A.). *Calcium sulphate hemihydrate.* Nature, London, 1934, vol. 133, p. 648.

$CaSO_4.\frac{1}{2}H_2O$ has been grown as relatively large crystals. It is trigonal, forms $(10\bar{1}0)$, $(01\bar{1}2)$, (0001), cell-sides a 6·76, c 6·24 Å., 3 mols. per unit cell. The water is zeolitic in nature. M. H. H.

Structure of Silicates.

Bragg (W. L.). *The structure of silicates.* Second, enlarged edition, Leipzig (Akademische Verlagsgesellschaft), 1932, 78 pp., 27 figs. Price 4·50 Mk. [Cf. M.A. **4**–354.]

Bragg (W. L.). *The exploration of the mineral world by X-rays.* Rep. Brit. Assoc. (Aberdeen, 1934), 1934, pp. 437–444, 1 pl., 5 text-figs.; Nature, London, 1934, vol. 134, pp. 401–404, 3 figs.

A popular account of the crystal-structure of silicates based chiefly on the geometry of the tetrahedral and octahedral groupings of atoms. F. A. B.

ACHATSCHKI (Felix). *Kristallchemie der Silikate.* Geol. För. Förh. Stockholm, 1933, vol. 54 (for 1932), pp. 447–470, 10 figs.

A discussion of the structure of the silicates on the lines indicated r W. L. Bragg [M.A. **4**–354]. L. J. S.

ro (Tei-ichi). *A possible form of Si_3O_8 groups in silicates.* Proc. Imp. Acad. Tokyo, 1933, vol. 9, pp. 53–55, 3 figs.

—— *The Si_3O_8 chains in space-groups V_h^{16} and C_{2h}^5.* Ibid., 1933, vol. 9, pp. 528–530, 4 figs.

Tetrahedral groups $(SiO_4)^{-4}$ can, by sharing corners, be linked into ains of composition $(Si_3O_8)^{-4}$. Two alternative methods of linking ese chains in three dimensions lead to monoclinic and orthorhombic ructures which have the same space-group and approximately the me unit-cell dimensions as eudidymite and epididymite respectively. F. A. B.

YLOR (W. H.). *The nature and properties of aluminosilicate framework structures.* Proc. Roy. Soc. London, Ser. A., 1934, vol. 145, pp. 80–103, 4 figs.

The crystal-structures of many aluminosilicates are based upon mework structures in which every tetrahedral SiO_4 or AlO_4 group ares all its corners with other tetrahedra; such compounds possess emical formulae in which the ratio (Si + Al) to O is 1 to 2. Framerk structures always possess a secondary unit consisting of a ring four tetrahedra. They are classified as: (1) Rigid and self-pporting frameworks; examples, analcime and chabazite. (2) ameworks containing rigid units of tetrahedron chains; exampl s, omsonite, edingtonite, natrolite, scolecite, and mesolite. (3) Non-id frameworks containing collapsible chains; example, felspars. Collapsible frameworks; examples, sodalite and the artificial tramarines. (5) Frameworks infinite in two dimensions but of ite thickness; examples, heulandite and stilbite. Two types of omorphous replacement are observed in minerals with framework ructures. Divalent kations replace monovalent kations of the me size in the same cavities, the valencies being balanced by teration of the aluminium to silicon ratio, e.g. $KSi \rightleftarrows BaAl$ and $Si \rightleftarrows CaAl$ in the orthoclase-celsian and albite-anorthite felspars. addition, a second type of replacement occurs in zeolites, viz. $\rightarrow Na_2$, empty cavities in the framework being occupied when dium replaces calcium. Both types of replacement (base-exchange) n be produced in zeolites without destroying the crystal-structure

because the frameworks are penetrated by channels large enough to permit the movement of kations and water molecules. The dehydration properties of zeolites are also due to these channels. The binding of the water molecules in zeolites (and in ordinary hydrated salts) satisfies the tetrahedral positive and negative bonds which Bernal and Fowler have ascribed to the molecule in liquid water. Twinning and intergrowths are frequent in felspars and zeolites because the frameworks are simple structures and possess a high structural symmetry to which the actual dimensional symmetry approximates. F. A. B.

Warren (B. E.). *The role of silicon and aluminum in complex silicates.* Journ. Amer. Ceramic Soc., 1933, vol. 16, pp. 412–417, 6 figs.

Taylor (W. H.). *Structure of sillimanite and related materials.* Ibid., pp. 418–420, 1 fig.

Nahmias (M. E.). *Bauxites and mullites.* Ibid., pp. 420–421.

These papers from the second symposium on the physical chemistry of alumina-silica refractories give reviews of work on the aluminium silicates. The several suggestions as to the nature and structure of mullite are shortly discussed. [Cf. M.A. **4**–32, **5**–214.] M. H. H.

Eitel (W.), Herlinger (E.), & Trömel (G.). *Zur Krystallchemie der Alumosilicate. Beziehung der Anorthitgruppe zur Gruppe des Nephelins.* Die Naturwissenschaften, 1930, vol. 18, pp. 469–474, 3 figs.

The relations between anorthite $CaAl_2Si_2O_8$ and nepheline $NaAlSiO_4$ are discussed, and a large number of corresponding compounds were prepared with other alkalis in place of Na and rare-earths in place of Al. The following are some of the data given by X-ray powder photographs and optical measurements.

	a.	c.	ω_{Na}.	ϵ_{Na}.
$NaAlSiO_4$	9·98 Å.	8·44 Å.	1·537	1·533
$KAlSiO_4$	10·41	8·70	1·532	1·527
$NaYtSiO_4$	10·79	8·80	1·832	1·844
$CaYt_2Si_2O_8$	10·79	8·80	—	—
$NaLaSiO_4$	11·01	8·96	1·867	1·840
$KLaSiO_4$	11·01	8·96	1·867	1·840
$CaLa_2Si_2O_8$	11·01	8·96	1·880	1·874
$NaNdSiO_4$	10·89	8·85	1·889	1·861
$KNdSiO_4$	10·89	8·85	—	—
$CaNd_2Si_2O_8$	10·89	8·85	1·903	1·898

Nepheline and kaliophilite are not isomorphous [cf. Min. Mag. 569]. Rubidium-nepheline is orthorhombic corresponding with high-temperature form of kaliophilite. The rare-earth 'anor-es' and 'nephelines' all have the kaliophilite structure, and they n mixed crystals amongst themselves but not with the aluminium npounds. The results are discussed in relation with structural . geochemical theories. L. J. S.

RNADSKY (W.). *Quelques considérations sur l'étude chimique des alumosilicates.* Zeits. Krist. 1933, vol. 84, pp. 337–372.

A consideration of various problems of the chemistry of the minosilicates and the possible connexion between colour and stal-structure. F. A. B.

IEBOLD (E.). *Über die Isomorphie der Feldspatmineralien.* Neues Jahrb. Min., Abt. A, 1931, Beil.-Bd. 64, pp. 251–319, 15 figs., 1 table.

A résumé of the author's previous work on the felspar structures. aematic stereochemical formulae are suggested. Therm chemical a, lattice energy, and stability relations of felspars and related erals are also discussed. [M.A. **4**–31.] F. A. B.

ERGER (M. J.). *The silica framework crystals and their stability fields.* Zeits. Krist., 1935, vol. 90, pp. 186–192, 2 figs.

Tridymite and cristobalite possess open crystal-structures capable enclosing foreign ions which prevent them repacking at low mperatures to the quartz structure. The foreign ion may enter structure in order to balance the substitution of silicon by an ion lower valency. A graph is given showing the range of temperature composition over which solid solutions of the three silica-structure es are stable. Solid solution in the quartz structure is restricted a very small range and to small ions, e.g. hydrogen ion in chalce-ny. Chemical analyses show that native tridymite and cristobalite never pure silica and the uninverted high-temperature cristobalite curring in the flaws of opal is also probably impure silica. [M.A. 381.] F. A. B.

ANDENBERGER (E.). *Zur kristallchemischen Formel des Duparcits.* Schweiz. Min. Petr. Mitt., 1934, vol. 14, pp. 317–318.

Discussion of the formula of duparcite [M.A. **5**–292] in relation to Machatschki's formula of idocrase [M.A. **4**–357]. L. J. S.

Caillère (S.). *Étude de la déshydratation de la parasépiolite fibreux de Madagascar.* Compt. Rend. Acad. Sci. Paris, 1934, vol. 199, pp. 1626–1628.

A more sensitive thermal method than previously employed [M.A. **5**–334] gives the amounts of water driven off from a parasepiolite from Ampandrandava (n 1·49) as 12·06, 5·10, and 4·16 % at 100°, 270°, and 665° respectively. Examined by X-rays the mineral is a typical sepiolite, its diagram is unaltered (save for becoming slightly hazy) by heating to 465° (n becoming 1·54). At 675° all crystal-structure disappears (n remaining unchanged), but reappears at 1000° as that of enstatite, accompanied after heating at 1300°, by cristobalite (n becoming 1·61). Analysis: SiO_2 53·10, Al_2O_3 0·32, Fe_2O_3 1·31, FeO 0·26, CaO 1·27, MgO 24·87, $H_2O(-)$ 8·42, $H_2O(+)$ 10·11, total 99·66. These facts support the formula $H_4Mg_2Si_3O_{10}$, some of the H_2O in the mineral being not of constitution, and the decomposition on heating being to $2H_2O + 2MgSiO_3 + SiO_2$.

C. A. S.

Caillère (Simonne). *Sur la signification du phénomène d'incandescence présenté par certaines antigorites.* Compt. Rend. Acad. Sci. Paris, 1935, vol. 200, pp. 1055–1058.

X-ray examination of various α- and β-antigorites before and after dehydration at 650–720°, and (α-antigorites) after the incandescence at about 810° shows no initial difference between the structures of the two groups. α-Antigorite becomes amorphous on dehydration, but after incandescence recrystallizes to a mixture of olivine and enstatite. With β-antigorite this recrystallization takes place simultaneously with the dehydration. The reaction is $H_4Mg_3Si_2O_9 = 2H_2O + Mg_2SiO_4 + MgSiO_3$. [Cf. M.A. **5**–522.] C. A. S.

Migeon (Georges). *Sur la teneur en eau et la déshydratation des sépiolites.* Compt. Rend. Acad. Sci. Paris, 1935, vol. 200, pp. 471–474, 1 fig.

Seven different samples of sepiolites, after preliminary drying at 120°, were gradually heated to 1000° and the loss of water plotted against temperature. The curves are almost continuous, only showing slight indications of slackening at about 330°, 550°, and 750°. The composition of six of the samples are very similar: SiO_2 67·06–69·96, MgO 27·34–30·30, CaO 0–2·09, Al_2O_3 0·60–1·77, Fe_2O_3 0–0·71 (save one with Fe_2O_3 3·0 and FeO 0·5, cf. Caillère, M.A. **5**–334), CO_2 0–1·39, $H_2O + 120°$ 10·16–14·15, $H_2O - 120°$ 13·54–22·59, which

nitting H_2O- 120°) corresponds to $3SiO_2.2MgO.1{\cdot}5H_2O$. For the enth sample (with SiO_2 63·5 % and MgO 32·32) $4SiO_2.3MgO.2H_2O$ more suitable. C. A. S.

GEON (Georges). *Sur la variation du volume et les modifications du réseau des sépiolites en fonction de la température.* Compt. Rend. Acad. Sci. Paris, 1935, vol. 200, pp. 946–949, 1 fig.

The changes in volume that occur on heating six different sepiolites m 20° to 1100° during eight hours are plotted against temperature. pid contraction occurs at 220–400°, 750–840°, and 900–1100°, d slow in the intervals. These results combined with X-ray amination show a fairly regular emission of water up to 750°, at ich temperature a sudden evolution thereof occurred with formation enstatite and separation of silica, which above 900° assumed the rm of cristobalite. The temperatures of the changes depend to ne extent on the manner of heating. C. A. S.

NGCHAMBON (Henri). *Sur la sépiolite d'Ampandrandava (Madagascar).* Compt. Rend. Acad. Sci. Paris, 1935, vol. 200, pp. 949–951.

The same sample of sepiolite was heated for 12 hours at each of eries of temperatures separated by intervals of 20° from 20° to 00°, and examined in X-rays after each heating. Below 300° it is noclinic (sepiolite I) with a 23·2 (perhaps 46·4), b 15·7, c 5·32 Å., 37–90°. At 500° it is orthorhombic (sepiolite II) with a 20·6 (perps 41·2), b 16·6 (perhaps 8·3), c 5·32 Å. This form is stable to 0°, above which the diagram is that of enstatite, with separation SiO_2 as cristobalite. Sepiolite I is a true magnesian zeolite, the rous character of which is due to continuous chains of Si_4O_{11} nked together by Mg atoms and (OH) ions. Sepiolite II is devoid zeolitic properties. Above 750° the Si_4O_{11} chains change to SiO_3 ains with liberation of SiO_2. C. A. S.

NGCHAMBON (Henri). *Sur les propriétés de la sépiolite d'Ampandrandava.* Compt. Rend. Acad. Sci. Paris, 1935, vol. 200, pp. 1331–1333, 2 figs.

The curves obtained by plotting loss of water against temperature ow that sepiolite I is stable to 320°, in which interval it loses –14 % of its weight as zeolitic water, which is reabsorbed at the dinary temperature. Sepiolite II is formed at 350–450° with eversible loss of more water and of all zeolitic properties. This

still contains about 3·5 % H_2O (calculated on the initial weight), half of which is gradually lost between 500 and 700°, and the remainder rapidly at 750°. Dilatometric observations confirm the X-ray inference that the passage from sepiolite I to II is accompanied by a contraction in the width only of the fibres. C. A. S.

Sundius (N.). *Über die Mischungslücken zwischen Anthophyllit–Gedrit, Cummingtonit–Grünerit und Tremolit–Aktinolith.* Min. Petr. Mitt. (Tschermak), 1933, vol. 43, pp. 422–440, 4 figs. [Cf. M.A. **3**–153, **4**–528.]

Further discussion on the composition of these amphiboles and the gaps in the series. New analyses and optical data are given for anthophyllite, cummingtonite, and tremolite. L. J. S.

Chemical Crystallography.

Barth (Tom. F. W.). *Polymorphic phenomena and crystal structure.* Amer. Journ. Sci., 1934, ser. 5, vol. 27, pp. 273–286, 4 figs.

The following definition is given: 'Polymorphism includes every possible difference encountered in the crystalline lattice of a substance of constant chemical composition, excepting homogeneous deformations.' And the following classification: I, Polytypy, sluggish or delayed inversions with change of one type of structure into another, e.g. quartz and tridymite. II, Polysyngony, rapid inversions with preservation of the type of structure but change into another variant of the structure, e.g. α-quartz and β-quartz, orthoclase and microcline. III, Polytropy, gradual changes with preservation of the type of structure, e.g. sanidine and adularia, sodium nitrate. L. J. S.

Balarew (D.). *Über neuartige Mischkristalle.* Zeits. Anorg. Chem., 1926, vol. 156, pp. 301–308.

Balarew (D.) & Kandilarow (G.). —— *II–III.* Ibid., 1927, vol. 162, pp. 344–348; 1927, vol. 163, pp. 141–144.

Balarew (D.). —— *IV–VIII.* Ibid., 1927, vol. 165, pp. 192–194; 1927, vol. 167, pp. 237–240; 1927, vol. 168, pp. 154–162, 1 fig.; 1928, vol. 168, pp. 292–296; 1928, vol. 169, pp. 257–263, 1 fig.

—— *Über die innere Adsorption in Kristallsalzen. I–VI.* Kolloid-chem. Beihefte, 1930, vol. 30, pp. 249–296, 14 figs.; 1931, vol. 32, pp. 304–319, 6 figs.; 1931, vol. 33, pp. 279–316, 27 figs.; 1932, vol. 34, pp. 441–461, 3 figs.; 1933, vol. 37, pp. 180–214, 4 figs.; 1933, vol. 37, pp. 324–342, 13 figs.

LAREW (D.). *Allgemeine Theorie der Verunreinigung fester Systeme.* Zeits. Anal. Chem., 1934, vol. 96, pp. 81–91, 9 figs.

— *Die innere Adsorption in Salzkristallen.* Zeits. Krist., 1934, vol. 89, pp. 268–281, 8 figs.

The deep red $KMnO_4$-bearing crystals of $BaSO_4$ prepared by Grimm are not true mixed crystals, but consist of parallel aggregates of microscopic or sub-microscopic crystals in the interstices of ich the $KMnO_4$ is adsorbed. With adequate magnification (× 1000) n lines of deeper colour on a paler background are clearly visible. e more rapidly the precipitate is formed, the smaller the true lividuals and the more resistant the precipitate is to washing and gents tending to remove the permanganate. On long standing in MnO_4 solution, initially deep violet crystals become practically ourless. Numerous experiments are cited indicative of the porous ture of apparently single crystals of $BaSO_4$. Experiments are en indicating that there is a second metastable form of $BaSO_4$ and t the abnormal porosity of $BaSO_4$ crystals as compared with other ts is due to crystallization initially in the unstable form. Quite rsely crystalline $BaSO_4$ precipitates may carry very considerable ounts of water and small amounts of very many salts, and this ory of adsorption in interstices within the body of a crystal which really a parallel or sub-parallel growth of microscopic or sub-roscopic individuals is extended to explain numerous instances co-precipitation. The 'anomalous mixed crystals' of $FeCl_3$ and H_4Cl and the like are strictly analogous to the $BaSO_4$ crystals with sorbed salts. The sub-microscopic crystal individuals are identified h the mosaic blocks of the mosaic theory of crystal-structure. ner experiments are cited in support of the mosaic theory. A ory of crystal growth is put forward to account for the above enomena. It is deduced that a crystal must grow by deposition the corners and edges, the deposit spreading then over the faces. ery real crystal has a mosaic structure and contains some, though metimes very little, adsorbed impurity. A large variety of phenona are discussed and explained on the basis of the mosaic theory, ging from the colour changes in minerals under the action of heat adiation to conductivity and diffusion phenomena. In true mixed stals the elementary blocks of the mosaic each contain both nponents, while in solid solutions elementary blocks of the two nponents are packed together to form a macrocrystal.

M. H. H.

Stranski (I. N.). *Über die innere Adsorption in Kristallsalzen.* Kolloidchem. Beihefte, 1931, vol. 32, pp. 197–204.

Arguments are brought forward against Balarew's theory of crystal growth. M. H. H.

Grimm (H. G.) & Wagner (G.). *Neuartige Mischkristalle. II. Mischkristallbildung aus $BaSO_4$ und $KMnO_4$.* Zeits. Physikal. Chem. 1928, vol. 132, pp. 131–148, 2 figs.

Mixed crystals of $BaSO_4$ and $KMnO_4$ were obtained with up to 60 mols. % $KMnO_4$. The more permanganate-rich crystals were relatively unstable to reducing agents. Mixed crystals were also obtained with $KMnO_4$ and $SrSO_4$, $BaSeO_4$, $SrSeO_4$, $BaCrO_4$; and with KBF_4 and $BaSO_4$ and $KMnO_4$. M. H. H.

Chlopin (Vitalius) & Nikitin (Boris). *Zur Frage nach der Existenz der neuartigen Mischkristalle von den Typus $BaSO_4$ und $KMnO_4$.* Zeits. Physikal. Chem., 1929, Abt. A, vol. 145, pp. 137–151.

The method of radioactive indicators shows that the $BaSO_4$–$KMnO_4$ and similar systems are mixed crystals, probably of a lamellar nature possibly by irregular admixture of small units (a few unit cells only) of the two substances. The systems $(RaD)SO_4$ (i.e. $PbSO_4$)–$KClO_4$ and $RaSO_4$–$KClO_4$, $RbClO_4$, $CsClO_4$, and $KMnO_4$ were studied. M. H. H.

Wagner (G.). *Die röntgenographische Untersuchung des Mischkristallsystems $BaSO_4 + KMnO_4$.* Zeits. Physikal. Chem., 1929, Abt. B vol. 2, pp. 27–38, 4 figs.

Mixed $BaSO_4$–$KMnO_4$ crystals show Debyeograms intermediate between those of $BaSO_4$ and $KMnO_4$. The change in lattice dimensions is approximately proportional to the molecular composition. Hence they are true mixed crystals. $BaSO_4$ with 16 mols. % adsorbed $Ba(NO_3)_2$ shows no displacement of the $BaSO_4$ lines. M. H. H.

Kolthoff (I. M.). *De vorming en eigenschappen van neerslagen. Theorie der coprecipitatie. I–VI.* Chem. Weekblad, Amsterdam 1934, vol. 31, pp. 102–103; 230–237, 2 figs.; 244–251; 395–400; 526–533, 2 figs.; 550–558, 1 fig.; 598–602.

The several factors which lead to the production of crystalline precipitates which carry appreciable amounts of impurities are discussed, and it is shown how true mixed crystal formation, simple adsorption, and true co-precipitation may be distinguished. The

t term is applied where a layer of adsorbed foreign ions becomes closed by overgrowth of the crystal. Anomalous mixed crystal mation is discussed, and also the doubtful mixed crystals typified $BaSO_4 + KMnO_4$. M. H. H.

CHS (G.). *Allgemeine Gesetzmäßigkeiten der Gefüge- und Eigenschaftsänderungen bei Umwandlungsvorgängen.* Zeits. Metallkunde, Berlin, 1932, vol. 24, pp. 241–248, 21 figs.

The mechanism of polymorphic changes and the relation of supeructures to polymorphy are considered. It is shown that in certain ymorphic changes (e.g. γ- to α-iron) an intermediate stage in the usition can be detected, and even held awhile as a metastable ase, distinct from either initial or end product. In the case of n this intermediate stage has a tetragonal structure, the iron cell ng elongated along one axis. The metastable phase in the iron–bon system, martensite, has this intermediate tetragonal structure, bilized by the immobility of the carbon, which must separate as h to complete the reaction. It is this mechanism of the γ- to ron change that is essentially responsible for many features of the dmanstätten structure. Polymorphic changes of this type can ur at lower temperatures than changes involving nucleus formaon. The mechanism of such changes usually obeys the rule that mic movements are kept to a minimum, the initial and final tices having as many densely packed lattice-planes in common as ssible. The separable steps in a polymorphic change which does t involve nucleus formation are rearrangement of the lattice (involving only small movements of the atoms), and rearrangement of atoms. In certain cases a superstructure may have a different mmetry from the disordered phase, thus constituting a gradation wards ordinary polymorphy. M. H. H.

NEMANN (H.) & SCHRÖDER (O.). *Über die Entstehung und Ausbildungsform von Segregaten in metallischen Mischkristallen.* Zeits. Metallkunde, Berlin, 1931, vol. 23, pp. 269–273, 13 figs.

Besides the normal diffusion by atomic interchange, atoms can grate in the solid by the progressive movement of a row of atoms some lattice direction into a vacant place. This mode of diffusion cermed perfusion, and is confined to a few lattice directions. If regation of a new phase sets in from one or more nuclei in a single stal of a compound or mixed crystal in which perfusion is possible, segregating phase will grow principally in certain directions

which can be predicted. In a cubic substance these are usually octahedral planes. The Widmanstätten structure is thus explained.

M. H. H.

Rây (P. C.). *Isomorphism and chemical constitution: constitution of formic acid and formates.* Nature, London, 1934, vol. 133, pp. 646–647.

Many of the peculiar chemical properties of formic acid are explained by attributing to the formate ion the formula $[O = C \leftarrow OH]'$, with divalent carbon. The formate and nitrite ions have similar structures, and mixed crystals of several formates with the corresponding nitrites have been prepared (Ba, Sr, Cd, Zn, &c.).

M. H. H.

Kolkmeijer (N. H.) & Hengel (J. W. A. van). *Über das reguläre und das hexagonale Silberjodid.* Zeits. Krist., 1934, vol. 88, pp. 317–322, 2 figs.

Silver iodide has a cubic form stable above 146° C. It has also a cubic and a hexagonal form stable at lower temperature. These may be prepared by pouring into water AgI dissolved in silver nitrate solution or in potassium iodide solution respectively. Their structures are of the zinc-blende and wurtzite types. The density of the two modifications is nearly identical, being about 5·70. H. H.

Nowacki (Werner). *Übersicht über neue Strukturbestimmungen von Verbindungen AB_3.* Zeits. Krist., 1934, vol. 89, pp. 85–88.

A summary is given, with full references to the literature, of the structures of crystals whose composition is of the type AB_3.

H. H.

Crystal-optics.

Bailly (R.) & Mélon (J.). *Réalisation d'une expérience suggérée par M. Cesàro et relative à des phénomènes lumineux produits dans les cristaux biaxes par certains plans réfringents.* Bull. Acad. Roy. Belg., 1934, pp. 477–483, 4 figs.

G. Cesàro (1891) showed theoretically that if a plane-parallel plate of a biaxial crystal is cut so that the plane of the plate is normal to the optic axial plane and cuts the cone of internal conical refraction, a small pencil of light falling at a suitable angle on the plate should give after refraction, not only the cylinder of light resulting from internal conical refraction, but an extraordinary refracted pencil as well. After many failures, it has proved possible to realize this phenomenon experimentally, and to photograph it. M. H. H.

OST (H. J.). *An interference method of determining indices of refraction in the infra-red.* Journ. Roy. Soc. New South Wales, 1934, vol. 67 (for 1933), pp. 223–230, 2 figs.

Values obtained for a thin sheet of mica range from 1·581 = 4·95 μ) to 1·5925 ($\lambda = 0{\cdot}6532\,\mu$). L. J. S.

UBOI (Seitarô). *A straight-line diagram for determining plagioclases by the dispersion method.* Japanese Journ. Geol. Geogr., 1934, vol. 11, pp. 325–326, 1 pl., 1 text-fig.

A modification of the diagram previously given [Min. Mag. –108]. L. J. S.

ASSEUR (H.) & PIÉRARD (J.). *Application de la méthode des cannelures à la mesure du retard d'une lame cristalline dont la biréfringence présente une dispersion.* Zeits. Krist., 1934, vol. 89, pp. 24–31, 1 fig.

The positions of the dark bands seen in the spectrum of light, ich has passed through a thin crystalline plate and crossed nicols, e the birefringence. The authors work out the theory and apply to a plate of $CaPt(CN)_4.5H_2O$. H. H.

EMMLEIN (Georg). *Über Doppelbrechung in einer Calcitkugel.* Zeits. Krist., 1934, vol. 88, pp. 332–336, 4 figs.

Photographs were taken for various positions of the optic axis of e caustic curves obtained by refracting parallel light through a lcite sphere, the photographic plate being perpendicular to the ident light. H. H.

REK (M.). *Die Anisotropieeffekte zwischen gekreuzten Nicols im Auflicht.* Zeits. Krist., 1934, vol. 89, pp. 125–143, 6 figs.

— *Theorie der Anisotropieeffekte zwischen gekreuzten Nicols im Auflicht.* Ibid., pp. 144–155.

The author completes the mathematical development of the theory polarized light reflected from crystalline surfaces, which he initiated an earlier paper [M.A. **5**–123]. H. H.

ISHNAN (K. S.) & SESHAN (P. K.). *Orientations of impurity molecules included in crystals.* Zeits. Krist., 1934, vol. 89, pp. 538–540, 1 fig.

Use was made of the fact that the absorption of polarized light by olynuclear molecule varies with the direction of vibration to show at naphthacene molecules occurring as an impurity in chrysene

take up orientations nearly parallel to those of the chrysene molecules, and that the same applies to fluorene as an impurity in diphenyl. Observations on fluorescence lead to the same result.

H. H.

Theilacker (Walter). *Berechnung der Brechungsindizes des Guanidoniumjodids.* Zeits. Krist., 1935, vol. 90, pp. 77–81.

The refractive indices of guanidonium iodide, $C(NH_2)_3I$, were calculated theoretically from a knowledge of the crystal-structure and compared with the observed values. H. H.

Brasseur (Henri). *Note sur les propriétés optiques et la densité de* $Na_2CO_3.H_2O$. Zeits. Krist., 1935, vol. 90, p. 282.

In the light of Colby and Harper's new determination of the density of sodium carbonate [M.A. **6**–44] the author reconsiders the connexion between the observed and calculated values of the refractive indices and finds a satisfactory agreement. H. H.

Bruhat (Georges) & Grivet (Pierre). *Le pouvoir rotatoire du quartz pour les rayons perpendiculaires à l'axe et sa dispersion dans l'ultraviolet.* Compt. Rend. Acad. Sci. Paris, 1934, vol. 199, pp. 1034–1036.

The ellipticity of the privileged vibrations in a birefringent medium, as measured by the author's method (ibid., 1934, vol. 199, p. 852) increases in approximately inverse ratio to the wave-length from 19′ for λ 4358 to 38′ for 2537. The rotatory powers of rays perpendicular to the axis are of opposite sense to those of rays parallel thereto, but both powers have the same dispersion, the gyration surfaces for the different radiations being similar hyperboloids. C. A. S.

Sawatari (Mititaka). *On the dispersion of mullite.* Journ. Geol. Soc. Tokyo, 1933, vol. 40, pp. 161–163 (Japanese); abstract in Japanese Journ. Geol. Geogr., 1934, vol. 11, abstracts p. 9.

Sawatari (Michitaka). *Notes on the dispersion of mullite.* Mem. Ryojun College of Engineering, Ryojun, Manchuria, Inouye Commemoration vol., 1934, pp. 41–47, 1 pl., 2 text-figs.

Artificial mullite crystals obtained by fusing agalmatolite from Korea gave $\alpha_r - \alpha_c = 0{\cdot}010$, $\gamma_r - \gamma_c = 0{\cdot}009$. These values are about the same as for fibrolite, and do not agree with those of A. N. Winchell [M.A. **4**–207].

The second paper gives the optical data for mullite prepared ificially with varying amounts of Fe_2O_3 and TiO_2 (only traces of O_3 were taken up). Mullite containing Fe_2O_3 and TiO_2 has cactive indices overlapping those of fibrolite, but it can be dis-guished from this by the higher dispersion.

SiO_2.	TiO_2.	Al_2O_3 %.	α_D.	β_D.	γ_D.	$\alpha_F - \alpha_C$.	$\gamma_F - \gamma_C$.	2V.
28·20	0·80	71·43	1·644	1·646	1·657	0·011	0·013	53·7°
20·99	1·86	76·49	1·648	—	1·659 1·679	0·013	0·014 0·023	–

L. J. S.

MITA (Tôru). *Variations in optical properties, according to chemical composition, in the pyroxenes of the clinoenstatite-clinohypersthene-diopside-hedenbergite system.* Journ. Shanghai Sci. Inst., Sect. 2, 1934, vol. 1, pp. 41–58, 10 figs.

Data from the literature on monoclinic pyroxenes are tabulated plotted on triangular diagrams $CaSiO_3$–$MgSiO_3$–$FeSiO_3$, showing variation of α, β, γ, 2V, and $c:\gamma$, and of n_1, n_2, and extinction-gle on cleavage flakes. The diagrams do not apply to pyroxenes taining more than 2·5 mol. % R_2O_3 and more than 1 mol. % TiO_2.

L. J. S.

ROSSI (Frank). *Über die Rayleighsche Streustrahlung in Kristallen.* Zeits. Physik, 1934, vol. 92, pp. 425–461, 2 figs.

The theory of the Rayleigh scattering of light by crystals is veloped for orthorhombic, rhombohedral, hexagonal, and tetragonal bstances. The degree of depolarization of light $\lambda = 4040$ Å., attered at right angles from polished cubes of various substances s measured. The scattering in glass, rock-salt, and topaz is not olecular, whereas variation with temperature shows that the attering effect of quartz is molecular. A molecular effect is also served for calcite but agreement with theory is not quantitative.

F. A. B.

REJCI-GRAF (Hanna & Karl). *Fluoreszenzfarben von Mineralen.* Zeits. Krist., 1934, vol. 88, pp. 260–264.

A very large number of minerals were tested for fluorescence when uminated by a quartz lamp, the colour of the light being compared th Ostwald's scale. In most cases the fluorescence was very weak, t for aragonite, calcite, fluorite, synthetic ruby, spinel, willemite, d uranium compounds the light was sufficient for spectroscopic

analysis, while in aragonite, gmelinite, natrolite, opal, phosphorite, and strontianite a permanent phosphorescence was detected.

H. H.

Köhler (Alexander) & Haberlandt (Herbert). *Lumineszenzanalyse von Apatite, Pyromorphite und einigen anderen Phosphaten.* Chemie der Erde, 1934, vol. 9, pp. 88–99.

Several minerals from various localities were tested for fluorescence in ultra-violet light with variable results. Apatite shows a yellow or pale violet fluorescence or none. L. J. S.

Haberlandt (Herbert) & Köhler (Alexander). *Fluoreszenzanalyse von Skapolithen.* Chemie der Erde, 1934, vol. 9, pp. 139–144.

Scapolite from many localities was tested for fluorescence in ultra-violet rays, before and after ignition, and in liquid air. Variable results were obtained. The strongly fluorescent scapolite from Grenville, Quebec [M.A. **5**–506], contains $7{\cdot}72 \times 10^{-12}$g. Ra per gram of material. L. J. S.

Brown (W. L.). *Fluorescence of manganiferous calcites.* Univ. Toronto Studies, Geol. Ser., 1934, no. 36, pp. 45–54, 3 figs.

The reddish-yellow fluorescence of calcite in ultra-violet rays shows a rapid increase in intensity (measured from photographs) with increasing content of manganese up to a maximum at about 3·5 % $MnCO_3$, and then a gradual decrease. The refractive index and specific gravity increase regularly with the manganese content, while the molecular volume decreases. A suggested explanation of the fluorescence is based on the difference in sizes of the replacing atoms in the crystal-structure.

Locality.	% $MnCO_3$.	% $FeCO_3$.	Intensity of Fluorescence.	ω(Na).	Sp. gr.	Mol. vol.
Cumberland, England	—	—	—	1·6585	2·715	36·86
Martha mine, Ontario	0·24	—	0·11	1·6587	2·720	36·81
Grace mine, Ontario	0·55	0·45	0·42	1·6599	2·726	36·76
Wilberforce, Ontario	0·71	2·57	0·51	1·6619	2·749	36·59
Franklin Furnace, N.J.	2·34	—	0·63	1·6620	2·742	36·60
Phoenix, B.C. ...	3·00	—	0·68	1·6624	2·744	36·63
Granby mine, B.C. ...	3·63	0·90	0·71	1·6652	2·761	36·49
Franklin Furnace, N.J.	3·90	—	0·68	1·6636	2·755	36·53
,, ,,	4·87	—	0·65	1·6657	2·768	36·43
,, ,,	6·50	—	0·56	1·6677	2·780	36·35
,, ,,	14·30	0·36	0·15	1·6795	2·865	35·68
,, ,,	22·50	0·40	—	1·6919	2·945	35·15

L. J. S.

IRRETT (Richard L.). *A comparison of ultra violet sources for producing fluorescence in minerals.* Amer. Min., 1934, vol. 19, pp. 578–585, 2 figs.

The available sources of ultra-violet rays in the order of their ensity are: silica-glass mercury-vapour lamp, carbon arc with ecial cored carbons, iron arc (direct current of 50 volts), high tential iron spark (4000 volts with transformer), and argon bulb. e three first must be used with a filter to cut out the visible light. rves are given showing the intensities of these sources from 2230 4000 Å. in the ultra-violet and in the visible spectrum. Another ies of curves shows the ranges of transmission of ultra-violet rays various glass filters. The fluorescence of minerals is different der the different sources. Scapolite from Quebec does not respond wave-lengths shorter than 2950 Å., and shows a maximum at 00 Å., but only feebly to a weak source. The same mineral species y also show differences in behaviour. One specimen of willemite n Franklin Furnace, New Jersey, fluoresced for all wave-lengths m 3900 Å. down to the X-ray region, while another from the ne locality did not respond to wave-lengths longer than 3100 Å.

L. J. S.

Physical Properties.

e solid state of matter. International Conference on Physics, London, 1934. Papers and discussions, vol. 2. Cambridge (University Press), 1935, viii + 183 pp., 60 figs. Price unbound, 10*s*.

The collected papers and discussions delivered at a joint conference London in 1934 organized by the International Union of Pure and plied Physics and the Physical Society. The papers are divided o three sections: the 'Structure of molecules and of the ideal tice', the 'Deviations of real crystals from the ideal lattice structe', and 'Plasticity and strain hardening in crystals'. The open- survey by Sir William Bragg and the papers and discussions of second section form a useful summary of a branch of crystal- ysics of interest to mineralogists. The authors, with few exceptions, ve previously published their results in other journals (see previous ttracts).

F. A. B.

RMANN (C.). *Tensoren und Kristallsymmetrie.* Zeits. Krist., 1934, vol. 89, pp. 32–48.

The relations between the symmetry and directional properties of sotropic substances, e.g. specific heat, electric conductivity, and

elastic compressibility are derived in the usual form of determinants. It is shown that these can be simplified by a suitable choice of axes.

F. A. B.

Tertsch (Hermann). *Gerichtete Schleifhärtenversuche.* Anzeiger Akad. Wiss. Wien, Math.-naturwiss. Kl., 1934, pp. 203–205.

Tertsch (H.). *Über Schleifhärtenanisotropie.* Zeits. Krist., 1934, vol. 89, pp. 541–552, 2 figs.

A modification of Rosiwal's method [M.A. **1**–369] of measuring the variation of hardness in different directions on a crystal-face was tested on a cleavage-face of calcite. The results were in essential agreement with Pfaff's (1883) observations. H. H.

Schubnikow (A.). *Selbstschreibendes Pendelsklerometer.* Zeits. Krist. 1934, vol. 87, pp. 499–502, 5 figs.

The hardness of a crystal may be estimated from the rate of decay of the oscillations of a pendulum suspended from a knife-edge resting on a plate of the crystal. Apparatus for this purpose has been made by Kusnezow, Kolesnikow, Lawrentjewa, Rehbinder and Kalmowskaja. A simple device for making the instrument self-recording is here described. H. H.

Duch-Bernelin (*Mme*). *Contribution à l'étude de la dureté des cristaux suivant les différentes directions de l'espace.* Zeits. Krist., 1934, vol. 88, pp. 323–325, 1 fig.

An endless thread fortified with an abrasive passes over pulleys and is driven by a motor in such a way that it presses on a crystal at one point of its path. It is proposed to study by its means the hardness of crystals in various directions. H. H.

Tammann (G.) & Moritz (G.). *Die Dichteabnahme des Quarzes beim Reiben.* Zeits. Anorg. Chem., 1934, vol. 218, pp. 267–272, 1 fig.

When a coarse quartz powder is further finely powdered, the density may be reduced by as much as 10% if the pressure on the pestle is high. With 20 kg. pressure in an agate mortar, a very strong yellow-red luminescence is observed during the powdering. Density and luminescence are little affected by grinding under water. The unit-cell dimensions are not altered, the density change being due to the production of cavities in the grains, which do not extend to the surface. The transformation to β-quartz is hindered by the powdering. Cristobalite and silica-glass increase in density on fine powdering by about 2%. M. H. H.

rch (G. I.), Quarrell (A. G.), & Roebuck (J. S.). *The Beilby Layer.* Proc. Roy. Soc. London, Ser. A, 1934, vol. 145, pp. 676–681, 1 pl.

Highly polished metallic surfaces scatter electrons at random, reas etched surfaces yield regular ring diffraction patterns charac- stic of crystalline layers [M.A. **5**–514]. Metal vapours were densed in vacuo on polished and etched metal surfaces under ervation in an electron diffraction camera. The diffraction tern yielded by the metal deposit disappeared sometimes in a minutes if the receiving plate was polished, but remained perma- tly on an etched surface. The rapid fading of the diffraction tern after deposition on a metallic surface occurred without iceable broadening of the rings, whence it is concluded that only stal faces of the deposit in contact with the receiving plate are ied. The experiments afford a direct experimental proof of the lby 'liquid' layer and of its formation by polishing. F. A. B.

ylor (G. I.). *The mechanism of plastic deformation of crystals. Part I.—Theoretical.* Proc. Roy. Soc. London, Ser. A, 1934, vol. 145, pp. 362–387, 13 figs.

— *Part II.—Comparison with observations.* Ibid., pp. 388–404, 6 figs.

The theory of dislocations in an elastically isotropic body has been lied to explain the plastic deformation of single crystals of metals the cubic system. A single centre of dislocation moves through rystal always in a crystallographic direction under the action an infinitesimally small shearing stress, i.e. the strength of the terial is zero. When more than one centre of dislocation is present ir mutual interaction necessitates the application of a minimum aring stress below which plastic distortion or slipping cannot take ce. The number of dislocations increases with distortion, and the stance to shear will increase with the amount of distortion. This lanation of hardening by cold work coupled with the assumption t slipping occurs over limited lengths L in the slip-plane also ds to a parabolic relationship between shearing stress and strain ch is in agreement with the results of experiment for metals stallizing in the cubic system. The value of L calculated from eriment is about 10^{-4} cm. at room-temperatures, and therefore is the same order of magnitude as the spacings of faults in metals rock-salt observed by Goetz, Belaiew, and Zwicky. According

to the author's theory the part played by the system of faulting or mosaic structure is to limit the free motion of centres of dislocation. The actual strain takes place inside the 'blocks' of the mosaic structure and the crystallographic nature of the faults, i.e. whether they are boundaries of dendrites, a superstructure, or merely pores is immaterial. F. A. B.

Taylor (G. I.). *The strength of rock salt.* Proc. Roy. Soc. London, Ser. A, 1934, vol. 145, pp. 405–415, 2 figs.

An application of the author's theory of strain-hardening of metallic crystals (see previous abstract) to the plastic properties of rock-salt modified slightly, since the slip-planes of rock-salt are of the type (110) and slipping occurs in two planes simultaneously instead of one as in aluminium. The relationship between tensile stress and plastic strain is parabolic and in good agreement with experimental data. The strain in rock-salt occurs in the 'mosaic blocks' of the material where crystal order is perfect and the strength is determined by the distance L between centres of dislocation rather than by the crystallographic or atomic nature of the material. The value of L is of the order 10^{-4} cm. and depends upon the distance apart of the faults and the temperature. F. A. B.

Taylor (G. I.). *A theory of the plasticity of crystals.* Zeits. Krist. 1934, vol. 89, pp. 375–385, 2 figs.

A résumé of work already published [preceding abstracts]. F. A. B.

Berg (Wolfgang F.). *About the history of load of deformed crystals* Zeits. Krist., 1934, vol. 89, pp. 286–294, 5 figs.

The fine structure of a beam of X-rays, divergent only in a vertica plane, after reflection from the (100) cleavage of a crystal of rock salt can be interpreted as deformation along slip-planes due t shearing stress. It is possible to deduce whether the stress was th same over the whole crystal and whether it changed during the lif of the crystal. F. A. B.

Buerger (M. J.). *The nonexistence of a regular secondary structure i crystals.* Zeits. Krist., 1934, vol. 89, pp. 242–267, 6 figs.

The markings observed on cleavages of artificial bismuth crystal and alleged to be a secondary structure gridwork are proved to b

nslation-gliding striae. Other experimental evidence in favour of vicky's structure is discounted, and Zwicky's proof that a secondary ucture possesses a lower energy content than the ideal lattice is o shown to be incorrect. F. A. B.

OWAN (E.). *Die mechanischen Festigkeitseigenschaften und die Realstruktur der Kristalle.* Zeits. Krist., 1934, vol. 89, pp. 327–343.

The observed tensile strength of a crystalline material is considerly less than the theoretical value calculated on the assumption of ideally perfect lattice. The author reviews the evidence in favour Griffith's crack propagation theory and shows that it explains the tts more satisfactorily than do the various secondary structure and ock structure hypotheses [M.A. **5**–266, 346, 508]. F. A. B.

(A. H.). *The thermal expansion of silver, quartz and bismuth by X-ray measurements.* Zeits. Krist., 1934, vol. 89, pp. 282–285, 3 figs. [Cf. M.A. **5**–509, 510.]

The coefficients of thermal expansion of silver, quartz, and bismuth , within the limits of present measurement, the same whether asured by X-ray or optical methods. F. A. B.

ISHNAN (K. S.), CHAKRAVORTY (N. C.), & BANERJEE (S.). *Investigations on magne-crystallic action. Part II.—Paramagnetics.* Phil. Trans. Roy. Soc. London, Ser. A, 1934, vol. 232, pp. 99–115. [Cf. M.A. **5**–350.]

Measurements were made of the principal susceptibilities of paragnetic sulphates and double sulphates of Fe, Ni, Co, Mn, the stals of which are mostly monoclinic. Mn-Am sulphate is very bly anisotropic, with a difference of only 0·08 % between the ximum and minimum susceptibilities. The anisotropy is only ght in the nickel salts, but strong in those of iron and cobalt.

L. J. S.

ROCK (Lester W.). *Magnetic anisotropy in cobaltammine crystals.* Zeits. Krist., 1934, vol. 88, pp. 238–247, 1 fig.

The specific gravity, optic axial angle, and crystal system of venteen different cobaltammines were determined, and also their entation when floating in a heavy liquid under the influence of a agnetic field. H. H.

Aminoff (G.) & Broomé (B.). *Über Elektronenphotogramme von Graphit.* Zeits. Krist., 1934, vol. 89, pp. 80–85, 5 figs.

The structure of graphite obtained by X-rays was compared with that deduced from photographs got by transmission with fast electrons, in order to test the latter method. H. H.

Nix (Foster C.). *Photo-conductivity.* Reviews of Modern Physics, New York, 1932, vol. 4, pp. 723–766, 33 figs.

A résumé of recent work on the photosensitive properties of many insulating and semi-conducting materials including diamond, cinnabar, stibnite, bismuthinite, molybdenite, cuprite, galena, argentite, and rock-salt. A list of 189 papers of work on photoconductivity is appended. F. A. B.

Mathematical Crystallography.

Alexander (Ernst). *Bemerkung zur Systematik der eindimensionalen Raumgruppen.* Zeits. Krist., 1934, vol. 89, pp. 606–607.

In correction of an error it is shown that the groups C''_r and D''_r referred to in an earlier paper [M.A. **4**–155] have no separate existence. H. H.

Seitz (F.). *A matrix-algebraic development of the crystallographic groups. I.* Zeits. Krist., 1934, vol. 88, pp. 433–459.

A geometrical movement leaving the origin fixed and bringing the point (x_1, x_2, x_3) into coincidence with (x'_1, x'_2, x'_3) may be associated with the matrix having a_{ij} as the element in the i-th row and j-th column, where $x'_i = a_{i1}x_1 + a_{i2}x_2 + a_{i3}x_3$ $(i = 1, 2, 3)$. In this way every group of movements may be associated with a group of matrices, and this is worked out in detail for the usual 32 classes of symmetry. H. H.

Terpstra (P.), Donnay (J. D. H.), Mélon (J.), & Weerden (W. J. van). *Studies on Barker's determinative method of systematic crystallography.* Zeits. Krist., 1934, vol. 87, pp. 281–305, 11 figs.

An informal conference was held at Gröningen in August 1933 to discuss difficulties which had arisen in the use of Barker's determinative system [M.A. **4**–337, **5**–197]. British scientists unable to attend the meeting sent suggestions. The report of the conference is given here. It deals with ambiguous cases in Barker's rules, gives some auxiliary rules, and makes suggestions for arranging the data in book form and for use of the tables in crystal determination. H. H.

OLDYREV (A. K.) & DOLIVO-DOBROVOLSKY (V. V.)] Болдырев (А. К.) и Доливо-Добровольский (В. В.). Классификация, номенклатура и символика 32 видов симметрии кристаллографии.—BOLDYREW (A. K.) und DOLIWO-DOBROWOLSKY (W. W.). *Klassifikation, Nomenklatur und Symbole der 32 kristallographischen Symmetriearten.* Зап. Ленинград. Горн. Инст. (Ann. Inst. Mines, Leningrad), 1934, vol. 8, pp. 145–159, 1 fig. (Russ. with Germ. summary.)

The following names and symbols for the 32 crystal-classes are ered for discussion. [Cf. M.A. **3**–414–418.]

Agyral syngony.

Primitive,	G_0
Central,	G_0c

Monogyral syngony.

Axial,	G_1a
Planar,	G_1p
Planaxial,	G_1ap

Digyral syngony.

Axial,	G_2a
Planar,	G_2p
Planaxial,	G_2ap

Trigyral syngony.

Primitive,	G_3
Central,	G_3c
Axial,	G_3a
Planar,	G_3p
Planaxial,	G_3ap

Tetragyral syngony.

Primitive,	G_4
Central,	G_4c
Axial,	G_4a
Planar,	G_4p
Planaxial,	G_4ap
Gyroidoprimitive,	G_{4i}
Gyroidoplanar,	$G_{4i}a$

Hexagyral syngony.

Primitive,	G_6
Central,	G_6c
Axial,	G_6a
Planar,	G_6p
Planaxial,	G_6ap
Gyroidoprimitive,	G_{6i}
Gyroidoplanar,	$G_{6i}a$

Polygyral syngony.

Primitive,	G_3G_3
Central,	G_3C_3c
Axial,	G_3G_3a
Planar,	G_3G_3p
Planaxial,	G_3G_3ap

L. J. S.

LLER (Walter). *Logical symbols for point symmetry groups.* Amer. Min., 1934, vol. 19, pp. 412–420, 3 figs.

Yet another system of symbols for the thirty-two crystal-classes proposed. M. H. H.

ONNAY (J. D. H.) & MÉLON (J.). *Angles paramétriques de Barker dans une série cristalline homéomorphe.* Ann. (Bull.) Soc. Géol. Belg., 1933, vol. 57, pp. B 39–B 52, 2 figs.

In a homeomorphous series it may readily happen that, owing to ferences in habit, different members of the series may receive ferent settings under T. V. Barker's determinative system [M.A. 337]. While not seriously interfering with the determinative

object of the system, such behaviour indicates that the system cannot always lead to a morphologically correct setting, which must be sought by the Bravais method. M. H. H.

Donnay (J. D. H.), Tunell (G.), & Barth (T. F. W.). *Various modes of attack in crystallographic investigations.* Amer. Min., 1934, vol. 19, pp. 437–458, 1 fig.

Apart from physical properties, the study of crystals may be directed to three principal ends: determination, structure, and pure morphology. For determinative purposes the methods proposed by T. V. Barker [M.A. **4**–337], while arbitrary in many ways, are most effective, and allow of the identification of any crystal for which the necessary data have been tabulated. Structural study of crystals is best made by X-ray methods. It is pointed out that arbitrary rules for the orientation of the structural unit cell are desirable. X-ray data could also be used for determinative purposes. For purposes of pure morphological description, the lattice should be selected by the aid of the law of Bravais (maximum reticular densities); the axial directions are then selected so as to give the smallest primitive translations, unless there are special reasons (e.g. pseudo-symmetry) to adopt a different cell; finally, arbitrary conventions are proposed to settle the orientation of the axes so selected. [It would be preferable to retain the convention suggested by Barker for determinative work for axial orientation, if only to avoid confusion.] The relation between the morphological and structural lattices is shortly discussed, and it is concluded that much more data are necessary before any useful generalizations can be made. M. H. H.

Donnay (J. D. H.). *The theory of determinants applied to crystallography.* Amer. Min., 1934, vol. 19, pp. 593–599.

The theory of determinants is shown to give a particularly simple proof of the 'addition and subtraction laws' for the derivation of faces co-zonal with two given faces. A simple variant of the Weiss zone-law is that if three faces $(h_1\,k_1\,l_1)$, $(h_2\,k_2\,l_2)$, $(h_3\,k_3\,l_3)$ are co-zonal $|h_1\,k_2\,l_3| = 0$. The following theorems, readily proved from the theory of determinants, are believed to be new. If three faces (hkl) $(h'k'l')$, $(h''\,k''\,l'')$ are co-zonal, then the faces $(hh'h'')$, $(kk'\,k'')$, $(ll'\,l''$ are also co-zonal; also the groups of faces obtained by cyclic permutation of the indices of the first group, or by interchanging any pair of indices in the symbols of each face; or by adding to one index of each face any multiple of another index of the same face. In the

t case, it is shown how to derive the zone-symbol of the zone ntaining the new group of tautozonal faces. The theorems deduced ply equally to coplanar zone-axes. M. H. H.

RPSTRA (P.) & WEERDEN (W. J. van). *Graphical methods for the determination of reticular densities and lattice parameters.* Amer. Min., 1934, vol. 19, pp. 531–545, 8 figs.

Graphical methods are described (and their validity proved) for determination of reticular densities and of relative lattice parameters from a stereographic or gnomonic projection of a crystal with y zone [*uvw*] in the equator, as well as for the special case where equatorial zone is [001] or [010]. These generalized methods particularly useful in the rhombohedral classes. M. H. H.

ERGER (M. J.). *Lattice indices and transformations in the gnomonic projection.* Amer. Min., 1934, vol. 19, pp. 360–369, 5 figs.

A direct geometrical proof is given of the 'self-indexing character-ic' of a gnomonic projection on a plane normal to a crystallo-aphic axis [i.e. of the fact that all poles (*hk*1)—assuming the ojection plane is normal to the *c*-axis—map out a network of rallelograms]. The transformation of indices consequent on a ange of axes is discussed, and 'Goldschmidt's transformation' is alysed and its significant operations summarized. M. H. H.

ACOCK (M. A.). *A suggested form of crystallographic presentation.* Amer. Journ. Sci., 1934, ser. 5, vol. 28, pp. 241–254, 12 figs.

The form of tables of crystal-forms and angles suggested for use a contemplated new edition of Dana's 'System of Mineralogy' is simplification of V. Goldschmidt's method, giving in addition the gles of each face to the three pinakoidal planes. In certain cases se are the same as the ρ and ϕ angles of two-circle goniometry. . Min. Mag. **23**–574.] L. J. S.

NKUCHEN (I.). *A nomogram for computing structure factors.* Zeits. Krist., 1935, vol. 90, pp. 284–286, 1 fig.

A method is given by means of which the product of two or three es or cosines of angles, given as decimal parts of 180°, can be read by means of a ruler and a diagram formed by four parallel scales nstructed on the slide-rule principle. H. H.

Buttgenbach (H.). *Calcul de l'angle de deux faces cristallographiques.* Bull. Sci. Assoc. Élèves des Écoles Spéciales, Liége, 1934, no. 4, pp. 109–119, 6 figs.

Formulae are given for calculating the angle between any two faces in each of the seven systems. L. J. S.

Bonatti (S.). *Applicazione di metodi grafici generali alla rapida determinazione delle costanti dei cristalli e successivo tracciamento degli assi nel disegno ortografico.* Atti (Mem.) Soc. Toscana Sci. Nat., 1933, vol. 43, pp. 142–164, 11 figs.

Bonatti (Stefano). *Metodo grafico per il tracciamento degli assi dei cristalli geminati nel disegno ortografico.* Ibid., 1934, vol. 44, pp. —, 13 figs. (Reprint 18 pp.)

A graphic method for determining from the stereographic projection approximate values of the axial ratios, sufficient for the construction of the axial cross employed in the drawing of a crystal. Methods of drawing the axial cross for simple and for twinned crystals are explained. L. J. S.

Cavinato (Antonio). *Una generale soluzione del problema del calcolo e disegno di un geminato.* Periodico Min. Roma, 1934, vol. 5, pp. 255–263, 5 figs.

From the stereographic projection the directions of the two axial crosses for drawing twinned crystals are deduced. L. J. S.

Tertsch (H.). *Trachtrichtige Kristallzeichungen aus den Zentraldistanzen.* Zeits. Krist., 1934, vol. 88, pp. 460–465, 4 figs.

—— *Zur Trachtmessung an Kristallbildern.* Ibid., 1934, vol. 89, pp. 594–600, 5 figs.

The author explains his method for drawing pictures of crystals in such a way as to emphasize the habit of the crystal satisfactorily. [Cf. M.A. **5**–203.] H. H.

Miscellaneous.

Ulrich (František). *Výskyty jarositu a natrojarositu v Československu.* [Occurrences of jarosite and natrojarosite in Czechoslovakia.] Věda Přírodní, Praha, 1934, vol. 15, pp. 79–82.

Sekanina (Josef). *Jarosit od Petrova u Kunštátu.* [Jarosite from Petrov near Kunštát.] Příroda, Brno, 1934, vol. 27, pp. 238–240, 2 figs.

Earthy jarosite and natrojarosite are frequent as oxidation products of pyrite. New occurrences are noted in the Palaeozoic and

Algonkian sediments near Praha. In Slovakia natrojarosite occurs at Kremnica and Banská Štiavnica, in the manganese mines at Kišovce, and in the Carboniferous at Velká Toroňa. Jarosite forms earthy aggregates in Cretaceous sediments at Motyčín near Kladno in Bohemia, and in a graphite deposit at Petrov near Kunštát in Moravia. Figures and photomicrographs of well-developed crystals (cr) from the last-named locality are given in the second paper.

F. S.

Rädisch (Jindřich). *Výskyt tuhy v gabbru a erlanu ve všerubském průsmyku.* [The occurrence of graphite in a gabbro and in an erlanfels in the Všeruby pass.] Časopis Národního Musea, Praha, 1934, vol. 107, pp. 112–114.

Veinlets of graphite accompanied by haematite occur in gabbro and gabbro-diorite SE. of Všeruby (= Neumarkt) and at Sruby, Bohemia. They pass into the contact-metamorphosed rock (pyroxenic erlanfels). The graphite is of inorganic origin, and is rarer in basic eruptive rocks than in pegmatites and related granitic rocks.

F. S.

Vlasák (František) & Trousil (Zdeněk). *Galenit z dolu „Kníže Schwarzenberg" u Dučic.* [Galena from Prince Schwarzenberg mine at Dučice.] Věda Přírodní, Praha, 1934, vol. 15, pp. 164–168, 3 figs.

Films of galena flattened on (100) occur sparingly in crevices in coal at Dučice near Rakovník, central Bohemia. A skiagraph shows its distribution in the coal. X-ray powder photographs give a unit cell a 5·91 Å., identical with that of galena from hydrothermal veins.

F. S.

Zombory (László). *Adatok a vaskő-dognácskai gránátok kémiai összetételéhez.*—Zombory (L. *v.*) *Daten zur chemischen Zusammensetzung der Granate von Vaskő-Dognácska.* Mat. Természettud. Értesítő, Budapest, 1934, vol. 52, pp. 179–186 (Hung.), p. 187 (Germ. summary).

Analyses of garnets from the contact-zone prove them to be andradite. (The green garnets from these localities have hitherto been considered to be grossular.) The colour appears to depend on the content of manganese, the green crystals containing very little, and the brown or reddish-brown crystals more and more the deeper the colour. The greenish interior of a zoned crystal contained MnO

0·21%, while the very pale brown exterior portion contained 0·46%. Brown and deep reddish-brown crystals gave MnO 2·15 and 4·86% respectively, I, pale green translucent crystals (110) in schweizerite from St. Archangel mine, Dognácska. II, crystals (110), green with yellowish-brown shade, same locality. III, aggregate of pale brown crystals (211) on garnet-rock with calcite from Reichenstein mine, Vaskő. IV, aggregate of pale brown crystals (111) (211) on magnetite from Carolus mine, Vaskő. V, aggregate of reddish-brown translucent crystals (110) on garnet-rock with calcite, same locality. VI, aggregate of deep brownish-red translucent crystals (211) on altered diopside, same locality.

	SiO_2.	Al_2O_3.	Fe_2O_3.	FeO.	MnO.	MgO.	CaO.	Ign.	Total.	D_4^{20}.
I.	35·70	2·61	29·03	0·46	0·05	—	32·21	0·54	100·60	3·818
II.	35·10	0·68	30·42	0·33	0·21	0·35	32·38	0·47	99·94	3·838
III.	35·20	0·86	30·82	0·61	1·65	—	31·20	0·20	100·54	3·830
IV.	35·26	2·45	28·33	0·44	1·71	—	31·22	0·23	99·64	3·830
V.	34·80	0·55	30·33	0·40	2·95	0·16	30·29	0·32	99·80	3·873
VI.	35·37	2·31	28·22	0·42	4·04	—	29·31	0·28	99·95	3·880

V. Z.

Lhotský (Bohumil). *Idokras z kontaktního vápence u Dlouhé Lhoty.* [Idocrase from the contact-metamorphic limestone near Dlouhá Lhota.] Časopis Národního Musea, Praha, 1934, vol. 107, pp. 88–90.

Short-prismatic crystals of brown idocrase from Dlouhá Lhota, SW. of Benešov, Bohemia, show the forms *c a m h f e u ε θ p b t r s* [Dana's letters] and (325). Sp. gr. 3·365, ω 1·729, ϵ 1·723 (Na). Traces of fluorine are present. F. S.

Rodolico (F.). *Appunti sulla fosgenite di Monteponi.* Rend. R. Accad. Lincei, Roma, 1928, ser. 6, vol. 8, sem. 2, pp. 171–174, 4 figs.

Crystals of phosgenite from Monteponi, Sardinia, show the new forms π (11.11.9) and (12.7.0) [$a : c = 1 : 1{\cdot}0876$]. They show wide re-entrant angles in the prism-zone (but are not twinned). Analysis gave PbO 81·73, Ag 0·01, CO_2 7·91, Cl 13·06; sp. gr. 6·05.

L. J. S.

Rodolico (F.). *Ricerche cristallografiche sul cinabro di Idria.* Rend. R. Accad. Lincei, Roma, 1929, ser. 6, vol. 9, sem. 1, pp. 176–179, 2 figs.

New forms Ω (60$\bar{6}$7), Θ (11.1.$\bar{1}\bar{2}$.5) ?, Φ ($\bar{2}$.16.$\bar{1}\bar{4}$.7) [$a : c = 1 : 1\ 1453$].

L. J. S.

ODOLICO (F.). *Vesuviana del Monte Spinosa nel Campigliese.* Rend. R. Accad. Lincei, Roma, 1931, ser. 6, vol. 13, sem. 1, pp. 213–217.

Small green crystals of idocrase from the contact-zone of marble th granite gave ω 1·702, ϵ 1·700, sp. gr. 3·404; SiO_2 36·30, TiO_2 65, B_2O_3 nil, Al_2O_3 2·27, Fe_2O_3 2·27, FeO 2·04, MnO 0·11, MgO 35, CaO 35·14, Na_2O 0·61, K_2O 0·10, F 1·78, H_2O+ 0·34, H_2O- 06, total (less O for F) 100·37, agreeing with the formula $_6Al_2[Al(OH,F)](SiO_4)_5$. L. J. S.

ODOLICO (F.). *Diopside e tremolite del Monte Spinosa nel Campigliese.* Rend. R. Accad. Lincei, Roma, 1931, ser. 6, vol. 13, sem. 1, pp. 705–710, 1 fig.

Tremolite and diopside occur with idocrase in marble at its contact with granite. The tremolite gave $c:\gamma = 18°$, sp. gr. 2·966; O_2 57·62, TiO_2 0·04, Al_2O_3 1·41, Fe_2O_3 0·12, FeO 1·03, MnO trace, gO 23·48, CaO 13·94, Na_2O 0·26, K_2O 0·14, F trace, H_2O+ 2·25, $_2O-$ 0·04 = 100·33. The formula $CaMg_3(SiO_3)_4$ is considered to the correct one rather than $H_2Ca_2Mg_5(SiO_3)_8$ [but this opinion as reversed in a later paper, M.A. **5**–323]. The diopside has $\gamma = 37°$, sp. gr. 3·317; SiO_2 54·58, TiO_2 0·04, Fe_2O_3 0·62, FeO 38, MnO 0·02, MgO 17·49, CaO 24·76, Na_2O 0·32, K_2O trace, H_2O 69 = 99·84. L. J. S.

ONDOLINO (Rinaldo). *Sopra alcuni minerali di S. Marcel (Valle d'Aosta).* Periodico Min. Roma, 1934, vol. 5, pp. 123–139, 1 pl., 5 text-figs.

Measurement of crystals of piedmontite gave $a:b:c = 1·5754:1:$ 7942, $\beta = 64° 36'$, with nine forms including new (210) and $(\bar{2}21)$; $_{Na}:c = -10° 50'$, $a_{Tl}:c = -12° 40'$. Braunite crystals, (111) and 21), show multiple twinning on (101) giving pseudo-octahedral rms. Rhodonite sometimes as limpid almost colourless crystals, owed seven forms; measurements through a natural prism gave $_{Na}$ 1·7124, β'_{Na} 1·7316, α'_{Tl} 1·7181, β'_{Tl} 1·7344. Violane showed the rms (010) (110), and new (112) and $(\bar{1}11)$?; $c:\gamma = 31° 30'$. ystals of sphene (' greenovite ') were also measured; $2E_{Na}$ 51° 6'. L. J. S.

CHERILLO (Antonio). *Ricerche sulle pegmatiti del rio Masul (Merano).* Periodico Min. Roma, 1934, vol. 5, pp. 181–190.

The pegmatite of this locality in southern Tyrol [M.A. **4**–238] is latively rich in beryl (2–3 %). Analysis of the beryl gave SiO_2

64·96, Al_2O_3 18·35, Fe_2O_3 trace, BeO 12·90, MgO 0·39, CaO 0·41, BaO 0·20, Na_2O 0·71, K_2O 0·18, H_2O+ 2·19, H_2O- 0·04 = 100·33; sp. gr. 2·703. Water is attributed to decomposition of the opaque material, and the formula is written as $R_3^{\prime\prime}Al_2Si_6O_{18}$. Analysis of the felspar of the pegmatite gave SiO_2 67·45, Al_2O_3 19·96, Fe_2O_3 trace, MgO 0·15, CaO 0·73, BaO 0·10, Na_2O 10·86, K_2O 0·50, H_2O- 0·11 = 99·86, corresponding with Ab 93·8, An 3·3, Or 2·7, Ce 0·2 %; sp. gr. 2·639, 2V about 80°. L. J. S.

Sanero (Edoardo). *Il giacimento di blenda di Vallauria* (*S. Dalmazzo di Tenda*). Periodico Min. Roma, 1934, vol. 5, pp. 113–122, 1 pl.

Good crystals of brown blende from this locality, near Cuneo in Piedmont, show twelve crystal-forms including new $(5\bar{3}3)$. Sp. gr. 4·047; analysis gave S 33·22, Zn 63·15, Fe 3·03, Mn 0·02, Pb 0·11, Cu 0·13, Bi 0·01, Cd 0·36, Sb 0·12, Ag 0·005, and traces of In, Ga, Sn, total 100·855. L. J. S.

Barboza (Octavio). *Nota sobre um interessante amfibolio* (*cummingtonita*). Ann. Acad. Brasil. Sci., 1934, vol. 6, pp. 53–56, 1 fig.

Skarn from Passagem mine, Minas Geraes, consists of matted needles of amphibole with dolomite, pyrite, and a little quartz. The amphibole has α 1·652, β 1·663, γ 1·679, 2V 81°, positive, $b = \beta$, $c : \gamma = 18° 48'$. L. J. S.

Hevesey (G. *v.*) & Würstlin (K.). *Über das Häufigkeitsverhältnis Zirkonium/Hafnium und Niob/Tantal.* Zeits. Physikal. Chem., 1928, Abt. A, vol. 139, pp. 605–614.

—— —— *Die Häufigkeit des Zirkoniums.* Zeits. Anorg. Chem., 1934, vol. 216, pp. 305–311.

—— —— *Über die Häufigkeit des Strontiums.* Ibid., vol. 216, pp. 312–314, 1 fig.

Hevesey (G. *von*), Merkel (A.), & Würstlin (K.). *Die Häufigkeit des Chroms und Mangans.* Ibid., 1934, vol. 219, pp. 192–196.

Chromium occurs mostly in ultra-basic rocks, while manganese and zirconium have no marked preference; the mean content in 282 intrusive rocks is Cr 0·053, Mn 0·098, Zr 0·022, Sr 0·011 %; in 187 extrusives Cr 0·074, Mn 0·158, Zr 0·023, Sr 0·033 %; in 300 clay-shales and phyllites Cr 0·036, Mn 0·089, Zr 0·012, Sr 0·002 %. In a moldavite Cr 0·033 and Mn 0·092 % were found; and in deep-sea red clay Cr 0·063, Mn 0·177, Zr 0·014, Sr 0·006 %. Three moldavites

ve mean values Zr 0·014, and Sr 0·010 %. Six meteoric stones ve mean values Zr 0·010, Sr 0·003 %. The average ratio Zr/Hf minerals is 50 : 1, and the ratio Nb/Ta approximately 1 : 1.

M. H. H.

LL (W.). *Zur Geochemie des Strontiums.* Fortschr. Min. Krist. Petr., 1932, vol. 17, pp. 62–64.

— *Geochemie des Strontiums. Mit Bemerkungen zur Geochemie des Bariums.* Chemie der Erde, 1934, vol. 8, pp. 507–600.

Many determinations were made, mostly by the X-ray spectro- pic method, of the minute amounts of Sr present in a variety of nerals and in igneous and sedimentary rocks. The average amount both SrO and BaO in igneous rocks is about 0·05%, but strontium a preference for alkali-rocks while barium occurs more in granitic ks. In the minerals of sedimentary rocks strontium is associated h calcium, but more in aragonite and anhydrite than in calcite, sum, and dolomite. L. J. S.

UPTMANN (H.) & BALCONI (M.). *Über die Bestimmung von Molybdän in Manganmineralen.* Zeits. Anorg. Chem., 1933, vol. 214, pp. 380–384.

Manganese peroxide minerals often contain appreciable amounts of lybdenum. A method for its colorimetric estimation has been rked out and applied to four deep-sea manganese nodules and a domelane. M. H. H.

ITMEIER (H.) & FEIGL (F.). *Eine einfache Reaktion zur Unterscheidung von Calcit und Aragonit.* Min. Petr. Mitt. (Tschermak), 1934, vol. 45, pp. 447–456, 2 figs.

A neutral mixture of manganese and silver sulphates is highly sitive to hydroxyl ions, reacting in accordance with the equation: $Mn^{··} + 2Ag^{·} + 4OH' = MnO_2 + 2Ag + 2H_2O$, with deposition of black MnO_2 and Ag. The reaction has proved highly efficient for the dis- tion of calcite and aragonite ; the latter reacts far more rapidly. e behaviour of other carbonate minerals towards the reagent has n investigated. The reaction is carried out in the cold, and is so ctly local that intimate intergrowths of calcite and aragonite can studied. The reagent was also used to study the thermal decom- ition of carbonate minerals ; the decomposition of calcite is found et in between 400 and 500° C., becoming marked at 600° C.; that magnesite is appreciable at 200° C., and marked at 280° C., while

dolomite commences to decompose about 250° C. and the decomposition is marked at 400° C. By use of the same reagent, the transition point of aragonite into calcite was found to be 405° C. M. H. H.

Tongeren (W. van). *Einige Bemerkungen zur Methode der Bestimmung der Alkalien in Gesteinen nach Lawrence-Smith.* Zeits. Anorg. Chem., 1934, vol. 218, p. 252.

The rock powder after weighing out is further ground under alcohol, and the grinding with NH_4Cl and $CaCO_3$ also performed under alcohol. The moist mass is transferred to the crucible, dried, and ignited. M. H. H.

Dixon (B. E.). *The determination of carbon in rocks and minerals.* Analyst, 1934, vol. 59, pp. 739–743, 1 fig.

A study of the determination of non-carbonate carbon in rocks and minerals shows that it is difficult to attain complete combustion to CO_2 by wet combustion with chromic and sulphuric, or chromic and phosphoric acids. The losses are due to formation of CO, and possibly of acetic acid, and to distillation of volatile hydrocarbons. Satisfactory results are obtained by interposing a second reaction flask of chromic and phosphoric acids plus a mercury catalyst between the decomposition flask and the absorption train. A procedure for use when carbonate is also present is described. M. H. H.

Faessler (A.). *Die Empfindlichkeit der chemischen Analyse mit Röntgenstrahlen.* Zeits. Physik, 1934, vol. 88, pp. 342–345.

The sensitivity of the X-ray spectrographic examination of materials is much greater for metals in the form of a button welded to the target of the X-ray tube than for powders rubbed on the surface of the target. By this method 1 part of Cr, Mn, Co, or Ni can be detected in 100,000 parts of iron. F. A. B.

Mélon (J.). *Contribution à l'étude de la kasolite.* Bull. Acad. Roy Belg., 1934, pp. 178–182, 1 fig.

New optical data were obtained by Fedorov stage methods and by the new method of optical path-differences: ax. pl. $\perp b$ (010), Bx_a, $c = +0{\cdot}5°$, 2V 43° 18′ (yellow), 42° 58′ (red), positive, γ 1·97 (assuming α 1·89, β 1·90). The new form (112) was observed ($a:b:c = 1{\cdot}8566:1:1{\cdot}6217$, $\beta = 76°\ 20'$). M. H. H.

ESSELOWSKI (W. S.) & WASSILIEW (K. W.). *Zwillungsbildungen bei Graphitkristallen.* Zeits. Krist., 1934, vol. 89, pp. 494–496, 4 figs.

Groups of twinned graphite crystals were obtained from Zavalye the Ukraine and artificially from cast-iron. They consist of gular arrangements of crystals in the basal plane with rotation rough 30° about the *c*-axis. H. H.

AD (R. E.) & LOOFBOUROW (Rodger W.). *A microchemical method of determining bournonite.* Econ. Geol. Lancaster, Pa., 1934, vol. 24, pp. 301–305, 1 fig.

An acid solution of azolitmin and potassium dichromate at 95° C. oduces on a polished surface of bournonite a film of brilliant nded colours changing with the time of treatment from blue rough green to yellow and red. L. J. S.

COCK (Martin) & SCHROEDER (Robert). *Über die kristallographischen Elemente des Carborund.* Centr. Min., Abt. A, 1934, pp. 113–121, 5 figs.

COCK (M. A.). *Nachbemerkung.* Ibid., pp. 121–122, 2 figs.

TELEZZI (Juana) & SCHROEDER (Robert). Ibid., pp. 123–128, 2 figs.

TELEZZI (Juana). *Sobre los cristales de carborundum.* Notas Prelim. Museo de La Plata, 1934, vol. 2, pp. 153–159.

The three types (trigonal and hexagonal) of carborundum disguished by H. Baumhauer (1912) were referred by him to one set axes, $a:c = 1:2{\cdot}4532$, but with complex indices for the faces. en the *c*-axis is multiplied by 5, 2, and 4/3 in types I, II, and respectively (giving the *c* values 12·2660, 4·9064, 3·2709) the ices form a normal harmonic series and the axes correspond with se obtained by X-ray methods [M.A. **3**–18, 177]. Goniometric asurements of crystals of type II from an unknown source gave $c = 1:4{\cdot}9065$. L. J. S.

RIN (F.). *Identité probable de la gosseletite et de la viridine (manganandalousite), occurence de la viridine à Salm-Château.* Ann. Soc. Géol. Belgique, 1934, vol. 57, Bull., pp. B 152–B 157, 1 fig.

Gosseletite [M.A. **3**–11] from manganiferous phyllites at Salmâteau, Belgium, has the same optical characters as viridine [M.A. 395] from Darmstadt. Pleochroism, α greenish-yellow, β intense en-blue, γ brownish-yellow, each with characteristic absorption

bands. The optical orientation to the three cleavages suggests triclinic symmetry; $\gamma : c = 7–8°$, 2V 73–78°. Aluminous phyllites at Salm-Château contain andalusite of the usual type. L. J. S.

Currier (L. W.). *Notes on staurolite and associated minerals from schists at Gassetts, Vermont.* Amer. Min., 1934, vol. 19, pp. 335–339, 1 fig.

A silvery-white mica-schist contains soda-rich muscovite, quartz, staurolite, almandine, kyanite, tourmaline, chlorite, biotite, rutile, and zircon. The staurolite crystals are flattened on *b* (010) and rarely twinned. L. J. S.

Zodac (Peter). *How to collect minerals.* Bull. 2, Rock and Minerals, Peekskill, N.Y., 1934, 80 pp., 15 figs. Price $1·00.

Hints to beginners on the formation, arrangement, and labelling of a collection, and how and where to collect minerals. L. J. S.

Zsivny (Viktor) & Zombory (László). *Berthierit kisbányáról.* Mat. és Természett. Értesítő, Budapest, 1934, vol. 51, pp. 506–511 (Hung.), pp. 512 (Germ. summary). [Cf. Min. Mag. **23**–566.]

Mayo (Evans B.) & O'Leary (Wm. J.). *Oligonite, a manganosiderite from Leadville, Colorado.* Amer. Min., 1934, vol. 19, pp. 304–308, 2 figs.

'Taffy-colored' mushroom-shaped masses of radiating material gave CO_2 37·98, FeO 26·18, MnO 35·28; sp. gr. 3·722, H. 3½, ω 1·840, ϵ' 1·695. L. J. S.

Palache (Charles). *Crystallography of the uranium oxides.* Amer. Min., 1934, vol. 19, pp. 309–315.

A revision of the crystallography of the following minerals with new orientations, new measurements, and some new crystal-forms. An analysis on a small amount of impure material of 'mineral X' from Great Bear Lake, Canada [M.A. **5**–333], suggests the formula $UO_3.2H_2O$. The same formula also probably applies to schoepite and becquerelite.

	Formula.	*a* : *b* : *c*.	Optical orientation *a*.	*γ*.
Schoepite ...	$3UO_3.7H_2O$ ...	0·4258 : 1 : 0·8745	*c*	*b*
'Mineral X' ...	$UO_3.2H_2O$(?) ...	0·490 : 1 : 1·04	*c*	*b*
Becquerelite ...	$4UO_3.7H_2O$ ...	0·5591 : 1 : 1·2100	*c*	*b*
Ianthinite ...	$2UO_2.7H_2O$ ...	0·4998 : 1 : 1·2964	*c*	*b*
Foumarierite ...	$PbO.4UO_3.5H_2O$ ...	0·4056 : 1 : 0·8832	*c*	*a*
Curite	$2PbO.5UO_3.4H_2O$	0·9595 : 1 : 0·6532	*c*	*a*

L. J. S.

RRARI (A.) & CURTI (R.). *I solfoarseniti di piombo.* Periodico Min. Roma, 1934, vol. 5, pp. 155–174.

A review is given of the literature on the several sulpharsenites of l. X-ray powder photographs of sartorite, baumhauerite, rathite, l dufrenoysite, and of solid solutions of PbS (up to 63·17 %) in S_3, all show the same prominent lines with the less important es varying in intensity. A crystallographic relation is traced ween orpiment and dufrenoysite (Pb_2AsS_5), and it is suggested t sartorite, liveingite, baumhauerite, and rathite are solid solutions his series, rather than distinct species. Guitermanite and jordan- give a different X-ray pattern. New analyses are given of torite (PbS 48·40, As_2S_3 48·58, Sb_2S_3 0·06; PbS 47·52, As_2S_3 79, Sb_2S_3 0·04) and rathite (PbS 57·84, As_2S_3 39·20, Sb_2S_3 1·35, 1·50) from Binn, Switzerland, and of guitermanite (PbS 74·27, S_3 22·74, FeS 2·53) from Silverton, Colorado. L. J. S.

VENS (R. E.). *Studies on the alkalinity of some silicate minerals.* Prof. Paper, U.S. Geol. Survey, 1934, no. 185–A, pp. 1–13, 1 fig.

arious minerals were ground with a few drops of water free from in an agate mortar for two minutes, and the p_H of the solution ermined colorimetrically or electrometrically. A selection of the ues given range from beryl 7·2, muscovite 7·8–9·0, calcite 9·0, hoclase 8·8–9·2, albite 9·4–9·8, olivine 10·2, wollastonite 10·3, ss 11·2–11·4. This is the order of stability of the minerals with pect to their resistance to weathering. The effect of silicate erals on underground waters and geochemical changes is dis- sed. L. J. S.

ECHLIN (R.). *Mineralogische Nachlese.* Centr. Min., Abt. A, 1934, pp. 256–266, 289–298, 9 figs.

The 'mineralogical gleanings' from the author's note-books going k almost fifty years give crystallographic measurements for the owing minerals. Sternbergite with miargyrite from Příbram, emia, a new locality. Laurionite: the axial ratios $a:b:c =$ 328 : 1 : 0·8315 given by the author in 1887 are considered to be re accurate than some later values [Min. Mag. **12**–102, **23**–574]. romerite, epsomite, blödite, and aphthitalite (new form $(20\bar{2}1)$) from lusz, Poland. Zeophyllite: $a:c = 1:1{\cdot}7103$, forms $c\,a\,r$, $s(05\bar{5}2)$. ena from Braubach, Nassau, distorted crystals of trigonal habit to elongation along a triad axis, with forms $a\,o\,d\,p\,q$ [Dana's

letters] and new η (552). Manganidocrase from Becco della Corbassera, Ala, Piedmont, forms *c a p t s i*. Phosphosiderite from Kirunavara, Sweden, $a:b:c = 0{\cdot}5321:1:0{\cdot}8770$, twinned on (101). Euclase, a blue crystal from Katohkar, Kamenka, Ural, new form (14.11.0), and several small faces with high indices. Pyrite crystals from Siegen, Westphalia, coated with a black cobalt-bearing mineral. Laumontite (leonhardite) from Floiten-Thal, Tyrol, enclosing rutile. Valentinite from Kogl, Brixlegg, Tyrol, forms (021), (378) [Dana's axes], A new (?) mineral from Gellivara, Sweden, a yellowish-brown prism with $a:b:c = 0{\cdot}8428:1:0{\cdot}8893$, forms c(001), b(010), m(110), d(011), e(704). Koechlinite has been found in collections labelled as 'uranospinite'. L. J. S.

Meen (V. Ben). *The etching of alpha and beta quartz.* Univ. Toronto Studies, Geol. Ser., 1934, no. 36, pp. 37–43, 1 pl., 2 text-figs.

Basal sections of α-quartz from Hot Springs, Arkansas, and of β-quartz from quartz-porphyry from Penticton, British Columbia were embedded in bakelite and polished, and after etching in 6·5% HF for 46 hours, they were examined under oblique surface illumination. The edges of the minute triangular etch-pits are parallel to the horizontal crystal axes. The α-quartz is untwinned or twinned regularly over large areas, while the β-quartz is badly fractured and heterogeneously twinned. L. J. S.

Harada (Zyunpéi). *Über die Lichtbrechung des Scheelits von Japan.* Journ. Fac. Sci. Hokkaido Univ. Sapporo, Ser. 4, 1934, vol. 2, pp. 279–287.

Refractive indices, determined by the prism method for light of several wave-lengths, are given for brownish-yellow to brown scheelite from four Japanese localities. They show some variation, for sodium light ω 1·9204–1·9227, ϵ 1·9368–1·9391, but with no difference in the birefringence and dispersion. L. J. S.

Harada (Zyunpéi). *Über einen neuen Pektolithfund in Japan.* Journ. Fac. Sci. Hokkaido Univ. Sapporo, Ser. 4, 1934, vol. 2, pp. 355–359, 1 plate.

Pectolite, previously not recorded from Japan, is described from five localities. It occurs as white radiating fibrous masses in serpentine and basic rocks. X-ray powder photographs are given. Analyse

A. Kan'nari: I, from Simekappu, prov. Isikari; II, Horokanai, v. Isikari; III, Utonai, prov. Tesio.

SiO_2.	Al_2O_3.	FeO.	CaO.	Na_2O.	K_2O.	H_2O.	Sp. gr.	α.	β.	γ.
53·35	0·14	0·20	33·90	9.20	0·34	3·14	2·87	1·595	1·605	1·633
52·89	0·21	0·14	33·85	8·81	0·19	3·66	2·86	1·594	1·603	1·631
52·73	0·24	0·10	33·93	8·90	0·37	3·36	2·86	1·595	1·604	1·632

Also traces of MnO and MgO in II and III.

L. J. S.

ERGER (N. W.) & BUERGER (M. J.). *Crystallographic relations between cubanite segregation plates, chalcopyrite matrix, and secondary chalcopyrite twins.* Amer. Min., 1934, vol. 19, pp. 289–303, 5 figs.

On polished and etched surfaces of a parallelepiped cut in chalcoite from Corinth, Vermont, it is proved that the enclosed lamellae cubanite are oriented parallel to the (111) faces of the chalcoite. The chalcopyrite shows a lamellar 'grid' twinning on (110), a polysynthetic 'echelon' twinning on (101). This twinning is ondary and is attributed to stresses produced during the unmixing he cubanite from the chalcopyrite. L. J. S.

SWORTH (H. V.). *Nickeliferous and uraniferous anthraxolite from Port Arthur, Ontario.* Amer. Min., 1934, vol. 19, pp. 426–428.

nthraxolite from rocks of late pre-Cambrian age is much veined h quartz and calcite, and is associated with sulphides, which could be completely separated. The essential ash of the material is mated at 0·16 %, and from an analysis of the impure ash this is mated to contain NiO about 39, U_3O_8 2, V_2O_3 0·5 %. L. J. S.

ORMICK (R. B.). *Paragonite from Pizzo Forno, Ticino, Switzerland.* Amer. Min., 1934, vol. 19, pp. 431–432.

The specific gravity varies from 2·82 to 2·90, owing to minute usions of kyanite and staurolite. For sodium-light α 1·5635, ·5960, γ 1·6020, 2V 42°. A partial analysis gave K_2O 4·6, Na_2O 7 %, corresponding with 37 % of the paragonite molecule. Pure agonite has not been found in nature. L. J. S.

WSON (Chester B.). *Sussexite from Iron County, Michigan.* Amer. Min., 1934, vol. 19, pp. 575–578.

ussexite occurs with seamanite [M.A. **4**–342] as veinlets of white yellowish fibrous material in the Chicagon iron mine. Sp. gr.

3·0–3·1, α 1·642, β 1·713, γ 1·721 ; analysis, B_2O_3 33·24, $Al_2O_3 + Fe_2O$ 0·29, MnO 40·42, MgO 14·57, CaO 0·35, SiO_2 0·89, insol. 0·65 $H_2O(+110°)$ 8·91 = 99·36. Other samples showed MnO 38–42 % with variations in the optical data. X-ray measurements are given L. J. S.

Kennard (T. G.) & Rambo (A. I.). *The extraction of rubidium and cesium from lepidolite.* Amer. Journ. Sci., 1934, ser. 5, vol. 28 pp. 102–109, 2 figs.

Lepidolite from Pala, California, after being sintered at about 1090° C. was decomposed with dilute H_2SO_4. Rubidium and caesium were precipitated from the alums with stannic chloride, and converted into bitartrates and then chlorides. The yield was Rb_2O 0·67 Cs_2O 0·16 %. L. J. S.

Fisher (Lloyd W.). *Growth of stalactites.* Amer. Min., 1934, vol. 19 pp. 429–431.

The average growth of calcareous stalactites in an inspection tunnel of the Gulf Island dam, Androscoggin river, Maine, varied from 0·2 to 2·30 inches per annum. Previous records from other localities range from 0·17 to 6·8 inches per annum. L. J. S.

Parsons (A. L.). *An unusual calcite crystal from Godfrey, Ontario.* Univ. Toronto Studies, Geol. Ser., 1934, no. 36, pp. 23–24 1 fig.

The crystal shows two hexagonal pyramids of the second order γ (8. 8. $\overline{16}$. 3) and π (11$\overline{2}$3). It is penetrated, probably in twinned position, by a smaller crystal of scalenohedral habit. L. J. S.

Thomson (Ellis). *The mineralogy of the silver-uraninite deposits of Great Bear Lake, N.W.T.* Univ. Toronto Studies, Geol. Ser. 1934, no. 36, pp. 25–31, 2 figs.

Further specimens from the Eldorado and other mines have been examined, and the modes of occurrence and associated minerals noted. To the list of 24 minerals previously noted [M.A. **5**–235], galena psilomelane, and pyrolusite are now added. L. J. S.

Thomson (Ellis). *Telluride ores at Straw Lake, Ontario, and Eureka mine, Quebec.* Univ. Toronto Studies, Geol. Ser., 1934, no. 36 pp. 33–36, 1 fig.

Polished sections show tetradymite, with native gold, galena pyrite, &c., in a quartz gangue. L. J. S.

ODHOUSE (C. D.). *A new occurrence of montroydite in California.* Amer. Min., 1934, vol. 19, pp. 603–604.

range-red, acicular or worm-like crystals of montroydite (HgO) ur with native mercury, eglestonite, calomel, dolomite, &c., in ures in silicified serpentine near Redwood City, San Mateo County.

L. J. S.

LB (Georg). *Zur Kristallmorphologie des Vesuvian.* Zeits. Krist., 1934, vol. 89, pp. 18–23, 6 figs.

he habit and vicinal faces of idocrase point to the fact that it ngs to the hexahedral isoharmonic class, as given by X-ray lysis. H. H.

COCK (M. A.). *On pectolite.* Zeits. Krist., 1935, vol. 90, pp. 97–111, 13 figs.

ectolite from Paterson and Union Hill, New Jersey, with the nposition $H_2O.Na_2O.4CaO.6SiO_2$ forms triclinic crystals with $a : b : c = 1{\cdot}1369 : 1 : 0{\cdot}9993$, $\alpha = 90° 23\frac{1}{2}'$, $\beta = 95° 14'$, $\gamma = 102° 42\frac{1}{2}'$, ring an isomorphous group with wollastonite, vogtite, schizolite, rosenbuschite. H. H.

COCK (M. A.). *On johannite from Joachimsthal and Colorado.* Zeits. Krist., 1935, vol. 90, pp. 112–119, 7 figs.

ohannite is identical with gilpinite, and is a hydrous copper nium sulphate whose exact composition is still uncertain. The tals are often pseudo-monoclinic owing to twinning on the axis he prism-zone, but are really triclinic with $a : b : c = 0{\cdot}9182 : 1 : 99$, $\alpha = 90° 54\frac{1}{2}'$, $\beta = 90° 38'$, $\gamma = 110° 37'$. H. H.

LOVITCH (Stoyan). *Action de la chaleur sur quelques oxydes de manganèse naturels.* Compt. Rend. Acad. Sci. Paris, 1935, vol. 200, pp. 71–73, 1 fig.

s a result of thermal analysis, and examination in X-rays and cted polarized light, it is found that: hausmannite shows no nge in air, nitrogen, or oxygen save development of twins with orption of heat at 950° to 1160°: Polianite (dried at 110°) in air orbs heat at 570° with loss of 9·8 % of its weight and formation of k Mn_2O_3, showing in X-rays the hausmannite structure but a htly different reflective power and corrodability [cf. M.A. **5**–206]; at 950° loses a further 3·34 % of its weight with slight absorp- of heat and formation of twinned hausmannite. Manganite in

air at 300° gives polianite, but in nitrogen Mn_2O_3, which at 940° passes into twinned hausmannite. In oxygen results with both polianite and manganite are as in air, save that on cooling Mn_3O_4 reoxidizes to Mn_2O_3. C. A. S.

Pelloux (Alberto). *Tinzenite e parsettensite della minera di Cassagna (Liguria orientale)*. Boll. Soc. Geol. Italiana, 1934, vol. 53, pp. 235–238.

Tinzenite and parsettensite associated with manganese oxides and quartz are briefly described from a manganese mine in the Graveglia valley. These manganese silicates have been previously recorded only from Switzerland [M.A. **2**–251, **3**–273]. L. J. S.

Barth (Tom. F. W.) & Balk (Robert). *Chloritoid from Dutchess County, New York*. Amer. Min., 1934, vol. 19, pp. 345–350, 1 fig. Correction, p. 608.

Brilliant dark-green flakes of chloritoid occur with garnet, &c., in phyllite from Clove Valley. Analyses of material enclosing some quartz, &c., and of the portion soluble in H_2SO_4 give the formula $H_2FeAl_2SiO_7$. The crystals are twinned and the variable optical characters suggest monoclinic symmetry. L. J. S.

Moehlman (Robert S.) & Gonyer (F. A.). *Monticellite from Crestmore, California*. Amer. Min., 1934, vol. 19, pp. 474–476. Correction, ibid., 1935, vol. 20, p. 138.

Monticellite separated from a rock containing also tilleyite, gehlenite, &c., gave SiO_2 37·46, FeO 3·98, MnO 0·52, MgO 22·78, CaO 35·20, H_2O 0·15 = 100·09, indicating that it is near the end-member $CaMgSiO_4$. Sp. gr. 3·083, H. 5½, α 1·6463, β 1·6535, γ 1·6605 (Na), 2V 78°, negative, $\alpha = b$; cleavage (010) poor. L. J. S.

Buerger (M. J.). *Fluid inclusions in pyrite*. Amer. Min., 1934, vol. 19, p. 605.

On crushing crystals of pyrite from Bingham (Utah) and Elba cavities and films of liquid were observed. Such films are not so readily detected on the conchoidal fracture of pyrite as on the cleavages of galena and blende [M.A. **5**–426]. L. J. S.

Aubel (René van). *Sur l'uraninite cristalline de Kasolo-Shinkolobwe (Katanga)*. Ann. Soc. Géol. Belgique, Publ. Congo Belge, 1935, annexe to vol. 58, pp. c 42–c 48. [Cf. M.A. **3**–401, **6**–33.]

X-ray powder photographs of uraninite from Kasolo give the edge of the unit cube as 4·67 Å. L. J. S.

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